Appendix F
DEMAND ESTIMATES AND PROJECTIONS

In the Lower West Coast (LWC) Water Supply Plan, demand assessments for 1995 and projections for 2020 were made for the following water use categories:

- Public water supply
- Domestic self-supply (including small public supply systems)
- Commercial and industrial self-supply
- Recreational self-supply
- Thermoelectric power generation self-supply
- Agricultural self-supply

The first five categories are urban water uses and are discussed in the Urban Demand section of this appendix. The Agricultural Demand section contains the discussion of the agricultural self-supply water use category.

Water demand projections for the year 2020 included analyses under both 1-in-2 (average) rainfall conditions and 1-in-10 drought year conditions. Rainfall analysis is presented in Appendix B. Projections are based on current trends and circumstances and therefore imply an extension of current production, market, and legal circumstances.

The LWC Planning Area contains part or all of six counties. All of Lee County is within the LWC Planning Area boundaries, but only a portion of Collier, Hendry, Glades, Charlotte, and Monroe counties are within the boundaries. The portion of Collier County not within the LWC Planning Area is part of the Big Cypress National Preserve, and has no urban or agricultural water demand. All of the land in the LWC Planning Area portion of Monroe County is within the boundaries of either Big Cypress Basin National Preserve or Everglades National Park, and has no significant urban or agricultural demand. Much of the data used to estimate water demands is available only at the county level. For Hendry, Glades, and Charlotte counties, this data was adjusted so that the demands reported within this document are for the LWC Planning Area only. To distinguish between county level data and adjusted data, the portions of these counties within the LWC Planning Area will be referred to as the Hendry Area, the Glades Area, and the Charlotte Area.

URBAN DEMAND

Public Water Supply and Domestic Self-Supplied Demands

Public water supply (PWS) and domestic self-supply (DSS) demand assessments and projections have been developed for the District for 1995 and 2020. The DSS category includes small public supply systems with projected demands of less than 0.5 million gallons per day (MGD) as well as residents that supply their own water needs. Self-supplied residents may be either within utility boundaries or outside of utility boundaries (rural self-supplied).

The utility service areas used in this analysis were derived from the service areas detailed within District water use permits and utility plans. It was assumed that all projected population growth within areas being serviced by a utility would be connected to the PWS system. Current DSS demand within utility service areas was assumed to remain constant. The breakdown of populations within utility service areas into PWS supplied and DSS categories were modified in several instances based on utility input.

Population

The 1995 population within the LWC Planning Area is 590,939 and is projected to increase 68 percent to 992,805 in 2020 (U.S. Bureau of the Census, 1995; Bureau of Economic Business Research (BEBR), 1998).

1995 Population Assessments

U.S. Census data for 1995 were used as the basis for the 1995 permanent population and the distribution of that population. Block group level information from the 1995 estimated census count was used as the basic unit of analysis. Total population, total housing units, occupied housing units, and persons per occupied housing unit were retrieved from census data. The total units connected to a PWS system and total units self-supplied were obtained from the census data (U.S. Bureau of the Census, 1995).

Estimates of occupied units connected to PWS systems and occupied units that are self-supplied were calculated for each block group. It was assumed that the percentages of units occupied and the number of occupants per unit were the same for both PWS connected and DSS units. PWS and DSS block group populations were calculated by multiplying the number of occupied units by the number of persons per occupied unit for the respective block group (**Equation F-1**).

$$\textit{Block group population} = \textit{Occupied units} \times \textit{Persons per occupied unit} \qquad \textit{(F-1)}$$

The geographic areas represented by the census block groups and the utility service areas were input as polygon coverages into the District's Geographic Information System (GIS). Population density for those areas served by a PWS and those self-supplied were calculated for each block group generally assuming a uniform density within each. Satellite imagery was used to review decisions if necessary. The two coverages, census block group populations and utility service areas, were overlaid to create a polygon coverage with the attribute data from both coverages. PWS and DSS population assessments were then calculated for the new polygon coverage by multiplying the polygon area by the population density (**Equation F-2**). The permanent populations for each area were then totaled.

$$\textit{Permanent population for area} = \textit{Polygon area} \times \textit{Population density} \qquad \textit{(F-2)}$$

Any growth in population within a utility service area was assigned to that utility and the DSS population was assumed to remain the same. Any growth in population

within an area not being served by a utility was assigned to the rural self-supplied category.

2020 Population Projections

The medium range county projections, as published by the Bureau of Economic Business Research (BEBR) (1998), were used as the basis for population projections for 2020. In Lee and Collier County, the geographic distribution of the 2020 population was determined using traffic analysis zones (TAZs). TAZs were not available for the Hendry, Glades, or Charlotte areas, so the geographic distribution of the 2020 population was based on the population distribution in the 1995 estimated census block data or was determined from information in the counties' comprehensive plans. Population density was calculated assuming a uniform density within each zone.

The geographic areas represented by the TAZs, cities, and the utility service areas were input as polygon coverages into the District's GIS. The coverages were overlaid to create a new polygon coverage with the attribute data from the original coverage. Population estimates were then recalculated for the new polygon coverage by multiplying the area of the polygon by the population density (**Equation F-2**). The populations for each area were then totaled and controlled to the BEBR medium range population projection for each county.

Per Capita Rates

Per capita water use rates for 1995 for each utility were calculated by dividing raw water pumped by the population served by PWS utilities:

$$\textit{Per capita water use rates} = \textit{Raw water pumped}/\textit{Population served} \qquad \textit{(F-3)}$$

Population served by the utilities were determined using the population assessment methodology described above and refers to permanent resident population. The USGS and District pumpage reports provided raw water withdrawal data. This includes use by seasonal residents and tourists, commercial and industrial utility supply used, and the loses incurred in water delivery in addition to the use by permanent residents. Irrigation demand for PWS served households using private well water for their irrigation was not assessed due to the lack of available data.

DSS per capita rates within PWS utility service area boundaries were assumed to be same as for the utility serving that service area. The per capita rates for the DSS areas not served by public utilities were assumed to be the weighted-average of the PWS per capita rates for the county.

Per capita rates for 1995 were used to develop the base 2020 utility demand projections. Adjustments that were made to these projections to normalize them for 1-in-2 (average) and 1-in-10 drought year rainfall conditions are described below.

Demand Projection Calculations

Water demand projections for the year 2020 included analyses under 1-in-2 (average) rainfall conditions and under 1-in-10 drought year conditions. A 1-in-2 rainfall year is defined as rainfall with a 50 percent probability of being exceeded over a twelve-month period. A 1-in-10 drought year condition is defined as below normal rainfall with a 90 percent probability of being exceeded over a 12-month period. This means that there is a 10 percent chance that less than this amount will be received in any given year. Section 373.0361(2)(a)1, F.S. states that the level of certainty planning goals associated with identifying demands shall be based upon meeting demands during a 1-in-10 drought year event.

Drought conditions increase outdoor water use, mainly for irrigation, requiring adjustments to be applied to the water demand. The projections described in this appendix include the complete satisfaction of irrigation requirements. Irrigation requirements are equal to the difference between evapotranspiration and effective rainfall (**Equation F-4**):

$$\textit{Irrigation requirements} = \textit{Effective rainfall} - \textit{Evapotranspiration} \qquad \textit{(F-4)}$$

Effective rainfall is the rainfall that is stored in the plant root zone. Appendix B contains a discussion on the derivation of the 1-in-2 and 1-in-10 drought year rainfall values.

Changing rainfall levels and timing affect irrigation requirements, but agricultural and urban irrigation managers may not collectively respond proportionally to dissimilar rainfall patterns. Observed demand levels will vary based on irrigation managers' perceptions and responses to changing rainfall patterns. Realistically, same may allow plants to experience some level of stress before changing irrigation schedules, while others may habitually over water at a level that satisfies irrigation demands even during drought events.

Unadjusted Base Demand

Unadjusted base demand is calculated by multiplying population by per capita water use rate:

$$\textit{Unadjusted base demand} = \textit{Projected population} \times \textit{Base year per capita rate} \qquad \textit{(F-5)}$$

The difference between the monthly demand for the base year and the unconstrained demand for a 1-in-2 (average) or a 1-in-10 year will directly depend on the changes in the outdoor use, specifically, changes in irrigation. If the base year is a 1-in-2 year, then there is no need to adjust the base year to a 1-in-2 year. However, if the base year is significantly wetter or drier than average, then unconstrained demands for outdoor use will need to be adjusted proportionally.

Indoor water use does not increase during a drought and, therefore, does not need to be adjusted. Therefore, the adjustments are applied to that portion of PWS and DSS demand that is used outdoors.

1-in-2 Year Adjustments

In order to calculate 1-in-2 (average) year drought demands for utilities, there needs to be an estimation of the percentage of total use that is used outdoors. Letters were sent to directors of each of the utilities for which projections were being developed requesting their assessment of the percentage of their utilities' total demand that is used outdoors during a 1-in-2 year. In cases where utilities did not respond, the District used the following guidelines: 35 percent for those utilities perceived to have a low level of outdoor usage, 50 percent for medium usage, and 65 percent for high outdoor usage.

For any given utility, PWS demand for a 1-in-2 year is determined using the percent outdoor use and irrigation requirements for sod for both a base year and a 1-in-2 year. The irrigation requirements are calculated using the District's Modified Blaney-Criddle irrigation requirement model. Below is an example of the calculation of a 1-in-2 demand for a utility.

Marco Island in Collier County has an assessed outdoor usage of 65 percent of total demand. The irrigation requirements for sod for 1995 and a 1-in-2 year are presented in **Table F-1** as millions of gallons per year (MGY). Rainfall and evapotranspiration data from the Naples rainfall station and a crop type of sod (100 acres) were used.

Table F-1. PWS 1-in-2 Year Adjustment Example (Marco Island).

1-in-2 irrigation requirement	134.1 MGY
1995 (base year) irrigation requirement	108.0 MGY
1-in-2 factor	1.242
Percent outdoor use	65%
PWS 1-in-2 adjustment	1.16

The PWS adjustment for a 1-in-2 year is determined using **Equations F-6** and **F-7**:

$$\textit{1-in-2 factor} = \frac{\textit{1-in-2 year irrigation requirement}}{\textit{Base year (1995) irrigation requirement}} \qquad \textit{(F-6)}$$

$$\textit{1-in-2 adjustment} = [(\textit{1-in-2 factor} - 1) \times \textit{percent outdoor use}]$$

The 1-in-2 annual demands would be 16 percent higher than those projections made using the base year of 1995 for Marco Island PWS utility.

A similar methodology was then used to assess the 1-in-2 year demands for DSS. For self-supplied residents within utility boundaries, the same percent outdoor use assessment was used as for the utility. A percent outdoor use assessment was also made for each county's rural self-supplied residents.

1-in-10 Drought Year Adjustments

For any given utility, PWS demand for a 1-in-10 drought year is determined using percent outdoor use, the 1-in-2 irrigation requirements for sod, and a 1-in-10 drought year irrigation requirement calculated using the District's Modified Blaney-Criddle model. The same percent outdoor use is used in both the 1-in-2 and 1-in-10 calculations. Below is an example of the calculation of a 1-in-10 drought year demand for a utility.

Continuing to use Marco Island as an example, this utility has an assessed outdoor usage of 65 percent of total demand. Irrigation requirements for 100 acres of sod for both a 1-in-2 year and a 1-in-10 drought year are presented in **Table F-2**. The same rainfall station, Naples, was used as in the 1-in-2 calculations above.

Table F-2. PWS 1-in-10 Drought Year Adjustment Example (Marco Island).

1-in-10 irrigation requirement	152.4 MGY
1-in-2 irrigation requirement	134.1 MGY
1-in-10 factor	1.136
Percent outdoor use	65%
PWS 1-in-10 adjustment	1.09

The PWS adjustment for a 1-in-10 drought year is determined using **Equations F-7** and **F-8**:

$$\textit{1-in-10 factor} = \textit{1-in-10 irrigation requirement}/\textit{1-in-2 irrigation requirement} \qquad \textit{(F-7)}$$

$$\textit{1-in-10 adjustment} = [(\textit{1-in-10 factor} - 1) \times \textit{percent outdoor use}] + 1 \qquad \textit{(F-8)}$$

Annual demands in a 1-in-10 drought year would be 9 percent higher than projections made for an average (1-in-2) year for the Marco Island PWS utility. No adjustments were made to 1-in-10 demands in consideration of conservation efforts to save water by users.

A similar methodology was then used to assess the 1-in-10 year demands for the DSS category. For self-supplied residents within utility boundaries, the same percent outdoor use assessment was used as for the utility. A percent outdoor use assessment was also made for each county's rural self-supplied residents.

Summary

Table F-4 summarizes the adjustment data for each utility and rural self-supply within the LWC Planning Area. **Table F-3** describes columns “a” through “o” in **Table F-4**.

The District recognizes the PWS utilities responsibilities to withdraw greater than average day demands to provide specific needs to the public for health, safety, and welfare purposes. The average day demands are utilized for determining likely effects to the resource over the planning period.

PWS demands listed in **Table F-4** are in terms of an average annual daily demand for document purposes. It is recognized that demands vary from month to month and this temporal variation is reflected in monthly demand figures used in the analysis. This information is not related in anyway to allocatable withdraws through the CUP process.

Table F-3. Column Legend for Public Water Supplied and Domestic Self-Supplied Demand Adjustments Table (**Table F-4**).

Columns	Heading	Description
a	#	Index numbers that match up with the maps in Appendix D showing utility withdrawal facility locations (**Figures D-1**, **D-2**, and **D-3**).
b	Utility	Name of the public water supply utility for which 1995 assessments and 2020 projections are made.
c	Total population	Population that resides within the utility's active service boundaries.
d	PWS population	Population served by the PWS utility.
e	PWS base (MGD)	For 1995, base year demands are the pumpage reported by the USGS and/or District pumpage records. For 2020, projected demands are based on the projected population served (column d) multiplied by the gallons per capita day (GPCD) observed in 1995 (column f) e = d x f
f	GPCD (gallons per capita day)	Per capita rate (GPCD) is calculated by dividing pumpage reported by the USGS and/or District pumpage records (column e) by population served by the PWS utility (column d). f = e/d
g	Percent outdoor use	Estimated average percentage of total utility withdrawal that is used outdoors, primarily for landscape irrigation.
h	1-in-2 factor	1-in-2 year irrigation requirements of 100 acres of sod divided by the 1995 irrigation requirements for that same area/crop as calculated by the District's modified Blaney-Criddle evapotranspiration model.
i	PWS 1-in-2 (MGD)	PWS base year demands (column e) multiplied by the impact of the percent outdoor use (column g) expressed as a decimal on the 1-in-2 factor (column h). i = e x (((h-1) x g) + 1)
j	1-in-10 factor	1-in-10 drought year irrigation requirements of 100 acres of sod divided by the 1-in-2 year irrigation requirements for that same area/crop as calculated by the District's modified Blaney-Criddle evapotranspiration model.
k	PWS 1-in-10 (MGD)	PWS 1-in-2 year demands (column i) multiplied by the impact of the percent outdoor use (column g) expressed as a decimal on the 1-in-10 factor (column j). k = i x (((j-1) x g) +1)
l	DSS population	Population not served by each PWS utility that resides within each utility's active service boundaries.
m	DSS base (MGD)	DSS population (column l) multiplied by the per capita rate (GPCD) observed in 1995 (column f). m = l x f
n	DSS 1-in-2 (MGD)	DSS base year demands (column m) multiplied by the impact of the percent outdoor use (column g) expressed as a decimal of the 1-in-2 factor (column h). n = m x (((h-1) x g) + 1)
o	DSS 1-in-10 (MGD)	DSS average MGD (column n) for each utility for 1995 and 2020 multiplied by the impact of the percent outdoor use (column g) expressed as a decimal and the 1-in-10 factor (column j). o = n x (((j-1) x g) + 1)

Table F-4. Public Water Supply and Domestic Self-Supply Demand Projections.[a]

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
	Utility	Total Pop.	PWS Pop.	PWS Base (MGD)	GPCD	Percent Outdoor Use	1-in-2 Factor	PWS 1-in-2 (MGD)	1-in-10 Factor	PWS 1-in-10 (MGD)	DSS Pop.	DSS Base (MGD)	DSS 1-in-2 (MGD)	DSS 1-in-10 (MGD)
Collier County														
1995														
1	Collier County Utilities	81,588	74,707	14.72	197	50%	1.242	16.50	1.136	17.62	6,881	1.36	1.52	1.62
2	Government Utility Authority	15,188	8,698	1.09	125	50%	1.242	1.22	1.136	1.31	6,490	0.81	0.91	2.97
3	Immokalee	21,448	21,281	2.49	117	35%	1.242	2.70	1.136	2.83	167	0.02	0.02	0.02
4	Naples	44,000	43,493	15.24	350	65%	1.242	17.63	1.136	19.20	507	0.18	0.21	0.22
5	Marco Island	10,603	10,529	5.5	522	65%	1.242	6.36	1.136	6.93	74	0.04	0.04	0.05
	Rural Self-Supplied	10,106			246	35%	1.242		1.136		10,106	2.49	2.70	2.82
1995 Totals		182,933	158,708	39.04				44.42		47.89	24,225	4.89	5.40	5.72
2020														
1	Collier County Utilities	189,415	182,534	35.97	197	50%	1.242	40.31	1.136	43.06	6,881	1.36	1.52	1.62
2	Government Utility Authority	19,612	13,122	1.64	125	50%	1.242	1.84	1.136	1.97	6,490	0.81	0.91	0.97
3	Immokalee	53,772	53,605	6.27	117	35%	1.242	6.80	1.136	7.13	167	0.02	0.02	0.02
4	Naples	58,206	57,699	20.22	350	65%	1.242	23.39	1.136	25.47	507	0.18	0.21	0.22
5	Marco Island	16,033	15,959	8.34	522	65%	1.242	9.65	1.136	10.50	74	0.04	0.04	0.05
	Rural Self-Supplied	12,162			246	35%	1.242		1.136		12,162	2.99	3.24	3.40
2020 Totals		349,200	322,919	72.44				82.00		88.13	26,281	5.40	5.95	6.29
Lee County														
1995														
1	Lee County Olga	62,143	47,576	3.09	65	35%	1.187	3.29	1.179	3.5	14,567	0.95	1.01	1.07
2	Lee County Corkscrew	35,807	34,795	5.65	162	35%	1.187	6.02	1.179	6.4	1,012	0.16	0.18	0.19
3	Cape Coral Utilities	91,458	73,840	8.62	117	35%	1.187	9.18	1.179	9.76	17,618	2.06	2.19	2.33
4	Lee County Waterway	7,559	7,289	0.95	130	35%	1.187	1.01	1.179	1.08	270	0.04	0.04	0.04
5	Greater Pine Island	7,277	6,788	1.25	184	35%	1.187	1.33	1.179	1.42	489	0.09	0.10	0.10
6	Island Water Assoc.	6,121	6,119	2.8	458	50%	1.187	3.06	1.179	3.34	2	0.00	0.00	0.00

Table F-4. (Continued) Public Water Supply and Domestic Self-Supply Demand Projections.[a]

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
	Utility	Total Pop.	PWS Pop.	PWS Base (MGD)	GPCD	Percent Outdoor Use	1-in-2 Factor	PWS 1-in-2 (MGD)	1-in-10 Factor	PWS 1-in-10 (MGD)	DSS Pop.	DSS Base (MGD)	DSS 1-in-2 (MGD)	DSS 1-in-10 (MGD)
7	City of Ft. Myers	44,359	44,031	6.51	148	35%	1.187	6.94	1.179	7.37	328	0.05	0.05	0.05
8	Lehigh	30,937	21,634	1.27	59	35%	1.187	1.35	1.179	1.44	9,303	0.55	0.58	0.62
9	Lee County Green Meadows	41,958	39,374	5.28	134	35%	1.187	5.63	1.179	5.98	2,584	0.35	0.37	0.39
10	Gulf Utilities	19,945	16,682	1.91	114	35%	1.187	2.04	1.179	2.16	3,263	0.37	0.40	0.42
11	Bonita Springs	21,105	19,323	2.87	149	35%	1.187	3.06	1.179	3.25	1,782	0.26	0.28	0.30
	Rural Self-Supplied	6,569			127		1.187		1.179		6,569	0.83	0.83	0.83
1995 Totals		375,238	317,451	40.20				42.91	1.179	45.68	57,787	5.70	6.02	6.35
2020														
1	Lee County Olga	76,991	62,424	4.05	65	35%	1.187	4.32	1.179	4.59	14,567	0.95	1.01	1.07
2	Lee County Corkscrew	44,831	43,819	7.12	162	35%	1.187	7.58	1.179	8.06	1,012	0.16	0.18	0.19
3	Cape Coral Utilities	165,961	148,343	17.32	117	35%	1.187	18.45	1.179	19.61	17,618	2.06	2.19	2.33
4	Lee County Waterway	8,215	7,945	1.04	130	35%	1.187	1.1	1.179	1.17	270	0.04	0.04	0.04
5	Greater Pine Island	9,940	9,451	1.74	184	35%	1.187	1.85	1.179	1.97	489	0.09	0.10	0.10
6	Island Water Assoc.	7,031	7,031	3.22	458	50%	1.187	3.52	1.179	3.83	0	0.00	0.00	0.00
7	City of Ft. Myers	57,247	56,919	8.42	148	35%	1.187	8.97	1.179	9.53	328	0.05	0.05	0.05
8	Lehigh	71,175	61,872	3.63	59	35%	1.187	3.87	1.179	4.11	9,303	0.55	0.58	0.62
9	Lee County Green Meadows	53,065	50,481	6.77	134	35%	1.187	7.21	1.179	7.66	2,584	0.35	0.37	0.39
10	Gulf Utilities	36,403	33,140	3.79	114	35%	1.187	4.04	1.179	4.30	3,263	0.37	0.40	0.42
11	Bonita Springs	37,863	36,081	5.36	149	35%	1.187	5.71	1.179	6.07	1,782	0.26	0.28	0.30
	Rural Self-Supplied	25,578			127	35%	1.187		1.179		25,578	3.24	3.45	3.67
2020 Totals		594,300	517,506	62.45				66.63		70.89	76,794	8.11	8.64	9.18
Hendry Area														
1995														
1	LaBelle	7,544	4,803	0.59	123	35%	1.111	0.61	1.166	0.65	2,741	0.34	0.35	0.37
2	Clewiston	14,446	13,814	3.25	235	35%	1.111	3.38	1.166	3.57	632	0.15	0.15	0.16
	Rural Self-Supplied	5,724			206	35%	1.111		1.166		5,724	1.18	1.23	1.30

Table F-4. (Continued) Public Water Supply and Domestic Self-Supply Demand Projections.[a]

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
	Utility	Total Pop.	PWS Pop.	PWS Base (MGD)	GPCD	Percent Outdoor Use	1-in-2 Factor	PWS 1-in-2 (MGD)	1-in-10 Factor	PWS 1-in-10 (MGD)	DSS Pop.	DSS Base (MGD)	DSS 1-in-2 (MGD)	DSS 1-in-10 (MGD)
1995 Totals		27,714	18,617	3.84				3.99		4.22	9,097	1.67	1.73	1.83
2020														
1	LaBelle	10,888	8,147	1.00	123	35%	1.111	1.04	1.166	1.10	2,741	0.34	0.35	0.37
2	Clewiston	20,850	20,218	4.76	235	35%	1.111	4.94	1.166	5.23	632	0.15	0.15	0.16
	Rural Self-Supplied	8,261			206	35%	1.111		1.166		8,261	1.70	1.77	1.87
2020 Totals		39,999	28,365	5.76				5.98		6.33	11,634	2.19	2.27	2.41
Glades Area														
1995														
1	City of Moore Haven	2,222	2,122	0.27	127	35%	1.182	0.29	1.163	0.3	100	0.01	0.01	0.01
	Rural Self-Supplied	2,187	0.00	0.00	127	35%	1.182	0.00	1.163	0.00	2,187	0.28	0.30	0.31
1995 Totals		4,409	2,122	0.27				0.29		0.30	2,287	0.29	0.31	0.33
2020														
1	City of Moore Haven	3,810	3,710	0.47	127	35%	1.182	0.50	1.163	0.53	100	0.01	0.01	0.01
	Rural Self-Supplied	3,750	0.00	0.00	127	35%	1.182	0.00	1.163	0.00	3,750	0.48	0.51	0.54
2020 Totals		7,560	3,710	0.47				0.50		0.53	3,850	0.49	0.52	0.55
Charlotte Area														
1995														
	Rural Self-Supplied	645	0	0.00	125	35%	1.111	0.00	1.166	0.00	645	0.08	0.08	0.09
1995 Totals		645	0	0.00				0.00		0.00	645	0.08	0.08	0.09
2020														
	Rural Self-Supplied	1,746	0	0.00	125	35%	1.111	0.00	1.166	0.00	1,746	0.22	0.23	0.24
2020 Totals		1,746	0	0.00				0.00		0.00	1,746	0.22	0.23	0.24

a. Table headings are described in detail in the previous table (**Table F-3**).

Urban demand is projected for Lee and Collier counties and the portions of Hendry and Glades counties located within the LWC (referred to as the Hendry and Glades areas.). The Charlotte Area is not included in the urban water demand analysis because the portion of the county within the LWC Planning Area has no PWS. Urban demands are concentrated in Lee and Collier counties, with these two counties accounting for approximately 96 percent of the LWC Planning Area urban population. About 16 percent of the 1995 population were self-supplied and this is projected to decrease to 12 percent in 2020 **(Table F-5)**.

Table F-5. Population in the Lower West Coast Planning Area 1995-2020.

County Area	1995 Population				2020 Population			
	Total	PWS	DSS	%PWS	Total	PWS	DSS	%PWS
Collier	182,933	158,708	24,225	87	349,200	322,919	26,281	92
Lee	375,238	317,451	57,787	85	594,300	517,506	76,794	87
Hendry	27,714	18,617	9,097	67	39,999	28,365	11,634	71
Glades	4,409	2,122	2,287	48	7,560	3,710	3,850	49
Charlotte	645	0	645	0	1,746	0	1,746	0
Total Planning Area	590,939	496,898	94,041	84	992,805	872,500	120,305	88

Commercial and Industrial Self-Supply

The types of employment available in an area depend on the commerce or industry located within the area. If the employment types can be anticipated to grow at the same rate and in the same direction as the population, than projected population can be used to determine the commercial and industrial self-supplied water demand. In the LWC Planning Area, the majority of the employees are found in the service and retail sales sectors. Water demand in these sectors will generally grow along with the population. Therefore, demand for this category of water use was projected to grow at the rate of each county's population growth. Commercial and industrial demands supplied by public utilities are included in the PWS demands.

The Lee and Collier counties are the only portions of the LWC Planning Area with reported commercial and industrial self-supplied demands (**Table F-6**). Estimates are provided both in terms of millions of gallons per year (MGY) and millions of gallons per day (MGD).

Table F-6. Commercial and Industrial Self-Supplied Demand.

County Area	Demand (MGY)	
	1995	2020
Collier County	2,181	4,163
Lee County	1,974	3,126
Hendry Area	0	0
Glades Area	0	0
Charlotte Area	0	0
Total Planning Area	4,155	7,289

Recreation

The recreational demand category includes self-supplied irrigation demands for large landscaped and recreational areas not supplied by utilities as well as reuse supplied by wastewater treatment facilities. Recreational demands supplied by utilities are included in the PWS demands. Because of the data sources available, golf course demands by county are projected separately and added to the other landscape and recreation demands. Nongolf course landscaping and recreational water use was assumed to increase at the same rate as the county population, with 1995 used as the base year. This is generally consistent with the methodology of the District Water Supply Assessment (DWSA). New courses constructed since the publication of the DWSA were included in this plan.

Recreation demand for each county and county area is presented in **Table F-7**.

Table F-7. Total Recreation Demand.

County Area	1995 Demand (MGY)				2020 Demand (MGY)			
		Golf Course				Golf Course		
	Landscape	Self-Supplied	Reuse	Total	Landscape	Self-Supplied	Reuse	Total
Collier County	10,093	6,548	4,772	21,413	19,267	14,161	11,358	44,786
Lee County	7,012	4,999	3,359	15,370	11,105	10,686	5,257	27,048
Hendry Area	0	267	14	281	0	267	14	281
Glades Area	0	24	9	33	0	24	9	33
Charlotte Area	0	0	0	0	0	0	0	0
Total Planning Area	17,105	11,838	8,154	37,097	30,372	25,138	16,638	72,148

Golf Courses

In the 1994 LWC Water Supply Plan, historical irrigated golf course acreage data were gathered from the Official Florida Golf Guide (Florida Department of Commerce, 1990), Golf Guide to the South (Florida Golfweek, 1989), the Golf Course (Cornish and Whitten, 1988), District water use permits, and personal communication with several of the golf courses listed. The primary source used to update this data was the 1997 Golf Course Directory published by the National Golf Foundation.

The primary statistical used for forecasting golf course acreage, which is also used for forecasting many of the agricultural acreages below, is multiple regression analysis. Multiple regression analysis refers to a group of techniques for studying the straight-line relationships among two or more variables. Multiple regression estimates the ßi's in the equation:

$$Yj = \beta_0 + \beta_1 X_{1j} + \beta_2 X_{2j} + \ldots \beta_p X_{pj} + \varepsilon_{\cdot j} \qquad (F\text{-}9)$$

where:

The X's are the independent variables.

The Y is the dependent variable.

The subscript, j, represents the observation (row) number.

The ß's are the unknown regression coefficients. Their estimates are represented by b's. A ß represents the original unknown (population) parameter, while b is an estimate of this ß.

The j is the error of the jth row.

Although the regression problem may be solved by a number of techniques, the most-used method is least squares. In least squares regression analysis, the b's are selected so as to minimize the sum of the squares. This set of b's is not necessarily the set you want, since they may be distorted by outliers (points that are a long ways from the rest of the data). An alternative to least squares regression is robust regression, a form of weighted least squares estimation.

In multiple regression analysis, we are studying the relationship between one dependent (response) variable and p independent variables (called predictors). The sample multiple regression equation is:

$$y\text{-}hati = b_0 + b_1 x_{i1} + b_2 x_{i2} + \ldots + b_p x_{ip} . \quad (F\text{-}10)$$

where:

If p = 1, the model is called simple linear regression.

The intercept, b_0 , is where the regression plane intersects with the Y axis.

The bi are the slopes of the regression plane in the direction of xi. These coefficients are called the partial-regression coefficients. Each partial regression coefficient represents the net effect the ith variable has on the dependent variable, holding the remaining X's in the equation constant.

Much of the regression analysis concerns the sample residuals, e_i, defined as

$$e_i = y_i - y\text{-}hat_i \quad (F\text{-}11)$$

Once the ß's have been estimated, various indices are studied to determine the reliability of these estimates. One of the most popular of these reliability indices is the correlation coefficient. The correlation coefficient, or simply the correlation, is an index that ranges from -1 to 1. When the value is near zero, there is no linear relationship. As the correlation gets closer to plus or minus one, the relationship is stronger. A value of one (or negative one) indicates a perfect linear relationship between two variables.

The regression equation is only capable of measuring linear, or straight-line, relationships. If the points were in a circle, for example, regression analysis would not detect a relationship. For this reason, it is always advisable to plot each independent variable with the dependent variable. The analyst watches for curves, outlying points, changes in the amount of spread about the straight-line, and various other anomalies that may occur.

If the data are a random sample from a larger population and the Ms are independent and normally distributed, a set of statistical tests may be applied to the b's and the correlation coefficient. These t-tests and F-tests are valid only if the above assumptions are met.

Specific assumptions of the ordinary least squares (OLS) multiple regression model are:

1. Linearity- Multiple regression models the linear relationship between Y and the X’s.
2. Constant variance (homoscedasticity)- The variance of the Ms is constant for all values of the X’s.
3. Absence of outliers- Special cases resulting from one-time conditions can result in violation of the constant variance assumption.

4. Normality- The error terms(M's) are assumed to be normally distributed. Non-normally distributed M's may make the results of hypothesis tests and confidence intervals unreliable.
5. Independence- The error terms are assumed to be uncorrelated; this implies that the Y's are also uncorrelated. Absence of independence in the error terms results from model mis-specification and/or serial correlation in time-sequenced data, such as the data being dealt with in the Appendix, Serial correlation among the error terms (most commonly tested for with the Durbin-Watson statistic) results in:
   - regression co-efficients which are unbiased but are not minimum variance;
   - serious underestimation of the means square error, which can result in inflated partial t-tests and confidence intervals which are too narrow;
   - any hypothesis tests or confidence limits based on the t-distribution or the F-distribution would be invalid.
6. Absence of multi-collinearity – Multi-collinearity is the existence of linear or nearly linear relationships among the set of independent variables. Multi-collinearity can result in inaccurate estimates of the regression co-efficients, inflated standard errors of the regression co-efficients, deflate the partial t-tests for the co-efficients, result in false non-significant p-values for the individual co-efficients and degrade the predictability of the model.

Once the regression equation has been estimated then projections can be developed for specified values of $x_{ij;}$ for the projections developed here one of the independent variables will always be a representation of the year. It can be seen here that, where multiple independent variables are present, to project a unique value Y_j – hat, it is necessary to know, project, or assume the value of each of the X_i's. Thus, projections made using multiple regression analysis maybe thought of as being based on at least two conditions:

1. The underlying relationship between the independent variables and the dependent variable does not change over time.
2. Appropriate values are input for each of the X_i's. (The above discussion draws heavily on Hintze, 1995, pp 357-361).

Irrigated acreage was projected through the year 2020 using trend analysis techniques. The method chosen to project Lee and Collier County irrigated golf course acreage used a linear projection model of the form shown in **Equation F-12**.

$CUMIRR_t = f(Time, Pop_t, D_t)$ *(F-12)*

where:

$CUMIRR_t$ = *Cumulative irrigated golf course acreage in Collier County in year t.*

Time = *A time trend variable which takes the value of one in 1953 and increases by one unit each year.*

Pop_t = *Reported, projected, or interpolated population (in thousands) in Collier County for year t.*

D_t = *A dichotomous variable equal to one in certain years and zero in other years. For Lee County D=1, for the period 1977 through 1985 inclusive. For Collier County D=1, for the period 1994 and after.*

Due to the small number of golf courses in the Glades, Hendry, and Charlotte Areas, golf course acreage in these areas was held constant at its 1995 acreage throughout the projection horizon.

"Goodness of fit statistics" are used throughout this appendix to evaluate the accuracy of equations in describing time series of historical acreage data. A detailed explanation of goodness of fit statistics can be found in "Econometric Models, Techniques, and Applications" (Intriligator, 1978) and in the on-line User's Guide to NCSS 2000 (Hintze, 1999).

Golf course irrigation requirement estimates were made for 1-in-2 (average) rainfall years and 1-in-10 year droughts using the District's modified Blaney-Criddle model. The irrigation requirements were calculated using a representative irrigation system/rainfall station/soil type combination for each county (**Table F-8**).

Table F-8. Input Variables Used to Determine Golf Course Irrigation Requirements.

County	Irrigation System			Soil	Rainfall Station
	Type	Used By	Efficiency		
Collier	overhead sprinkler	100%	75%	sandy soil with 0.4 inch usable soil water capacity per foot	Naples
Lee	overhead sprinkler	100%	75%	sandy soil with 0.8 inch usable soil water capacity per foot	Fort Myers
Hendry	overhead sprinkler	100%	75%	sandy soil with 0.8 inch usable soil water capacity per foot	LaBelle
Glades	overhead sprinkler	100%	75%	sandy soil with 0.8 inch usable soil water capacity per foot	Moore Haven

Collier County Golf

The golf courses presently in Collier County are described in **Table F-9**.

Table F-9. Historic Irrigated Golf Course Acreage in Collier County.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Naples Beach Hotel and Golf Course	1953	95	95
Hole-in-the-Wall Golf Course	1957	120	215
The Country Club of Naples	1960	115	330
Royal Palm Country Club	1960	125	455
Palm River Country Club	1961	75	530
Moorings Country Club	1963	38	568
Island Country Club (a.k.a. Marco Island)	1965	85	653
Hibiscus Golf Course	1968	110	763
Royal Poinciana Golf Course	1969	324	1,087
Brook Meadow Golf Course	1970	120	1,207
Glades Country Club	1972	199	1,406
High Point Country Club	1972	120	1,526
Quail Run Country Club	1972	55	1,581
Riviera Golf Course (a.k.a. Riviera Golf Course of Naples)	1972	85	1,666
Imperial Golf Course	1973	260	1,926
Wilderness Country Club	1974	120	2,046
Marco Shores Country Club	1975	80	2,126
Quality Inn Suite and Golf Club	1978	184	2,310
Lakewood Country Club	1979	48	2,358
Bears Paw Country Club	1980	144	2,502
Wyndemere Country Club (Homeowners Association)	1980	290	2,792
Pelican Bay	1980	100	2,892
The Club at Pelican Bay	1981	125	3,017
Eagle Creek Country Club	1982	160	3,294
Boyne South Golf Club	1982	457	3,751
Quail Creek Country Club	1982	19	3,770
Hideaway Beach Golf Course (a.k.a. Association Habitat)	1984	100	3,870

Table F-9. (Continued) Historic Irrigated Golf Course Acreage in Collier County.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Windstar on Naples Bay (a.k.a. Windstar Golf and County Club)	1984	228	4,098
Foxfire Country Club	1985	105	4,203
Lely Classic	1985	25	4,228
Bentley Village Golf Course	1987	12	4,240
Naples Golf Center	1987	153	4,393
Quail Village Golf Course	1987	285	4,678
Vineyards Golf and Country Club (a.k.a. Vineyards of Naples)	1987	203	4,881
Audubon Country Club	1988	65	4,946
Countryside Country Club (a.k.a. Countryside)	1988	132	5,078
Royal Wood Golf and Country Club	1988	119	5,197
Golf Club of Marco	1990	60	5,257
Silver Lakes	1991	170	5,427
Stoneybrook	1991	120	5,547
Valencia Golf Course (a.k.a. Valencia at Orange Tree)	1991	120	5,667
Marriot Golf Course at Marco	1991	120	5,787
Glen Eagle (a.k.a. Embassy Woods Golf and Country Club)	1991	300	6,087
Bonita Bay Club (a.k.a. Bonita Bay East)	1992	155	6,242
Shamrock Golf and Country Club	1992	139	6,381
Colliers Reserve Country Club (a.k.a. Colliers Reserve)	1993	48	6,429
Lakewood Country Club	1993	367	6,796
Quail West Limited	1993	55	6,851
Naples National Golf Course	1993	120	6,971
Stonebridge Country Club Association (a.k.a. Stonebridge Country Club)	1993	497	7,468
Grey Oaks Country Club (a.k.a. Grey Oaks Golf and Country Club)	1994	155	7,623
Heritage Green (a.k.a. Heritage Greens)	1994	119	7,742
The Country Club of Naples (a.k.a. Country Club of Naples)	1994	120	7,862
Pelican Marsh Golf Course	1994	25	7,887

Table F-9. (Continued) Historic Irrigated Golf Course Acreage in Collier County.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Ironwood Golf Course	1995	154	8,041
Kensington Golf and Country Club (a.k.a. Kensington)	1995	119	8,160
Marco Shore	1995	36	8,196
Naples Ex Country Club	1995	150	8,346
Naples Golf Estate	1995	240	8,586
Olde Florida Golf Course	1995	191	8,777
Orangetree Development	1995	255	9,032
Pelican Strand Community (a.k.a. Golf and County Club; Pelican Strand)	1996	125	9,157
Bay Colony Golf Course	1996	150	9,307
Arrowhead Golf Club	1998	72	9,379
Lely Mustang Golf Course (a.k.a. Lely Resorts)	1999	150	9,529
Lely Flamingo Island Club (a.k.a. Lely Resorts)	1999	150	9,607
Twineagles	1999	120	9,727
Cypress Woods	1999	155	9,882

Historic and projected population figures were not available for all years. Where actual population figures were not available, a linear interpolation between the two adjacent available population figures was made. This may tend to make population estimates used here more highly correlated with time than they actually are.

When **Equation F-12** was estimated using ordinary least squares regression to obtain the, **Equation F-13** was obtained.

The primary projections for Collier County irrigated golf course acreage are presented in **Table F-10**. Because forecasting is always associated with a degree of uncertainty, primary projections are presented with a band of plus or minus 15 percent around it.

The irrigation requirements in **Table F-11** were calculated by applying these projected irrigated acreages to both the 1-in-2 and 1-in-10 supplemental water requirements for grass (as calculated by the Blaney-Criddle permitting model). Input variables are presented in **Table F-8**.

(F-13)

Multiple Regression Report

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Dependent Cumacres

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	17840.45	3785.669	4.7126	0.000015	Reject Ho	0.996275
Year2	217.2498	145.2851	1.4953	0.140069	Accept Ho	0.312886
Popt	45.56182	12.44592	3.6608	0.000533	Reject Ho	0.949666
Logpop	-3195.975	1222.014	-2.6153	0.011258	Reject Ho	0.730167
D	-586.7435	157.5236	-3.7248	0.000434	Reject Ho	0.955863
R-Squared	0.984066					

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.667535E+09	1.667535E+09			
Model	4	5.363676E+08	1.340919E+08	926.3717	0.000000	1.000000
Error	60	8684974	144749.6			
Total(Adjusted)	64	5.450525E+08	8516446			

Root Mean Square Error	380.4597	R-Squared	0.9841
Mean of Dependent	5065.016	Adj R-Squared	0.9830
Coefficient of Variation	0.0751152	Press Value	1.0056E+07
Sum |Press Residuals|	20416.31	Press R-Squared	0.9816

Durbin-Watson Value 0.5908

Table F-10. Total Projected Irrigated Golf Course Acreage for Collier County.

Year	Primary - 15%	Primary	Primary + 15%
1995	7,677	9,032[a]	10,387
1999	8,400	9,882[a]	11,364
2000	8,765	10,312	11,859
2005	10,613	12,485	14,358
2010	12,428	14,621	16,814
2015	14,383	16,922	19,460
2020	16,395	19,288	22,182

a. From **Table F-9**.

Table F-11. Irrigation Requirements for the Primary Golf Course Acreage Projections in Collier County.

Year		1995	2000	2005	2010	2015	2020
Collier County Acreage[a]		9,032	10,312	12,485	14,621	16,922	19,288
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.20	372	448	542	635	735	838
February	1.46	452	545	660	773	895	1,020
March	3.37	1,044	1,258	1,523	1,784	2,065	2,354
April	4.21	1,304	1,572	1,903	2,229	2,580	2,940
May	4.55	1,410	1,699	2,057	2,409	2,788	3,178
June	3.70	1,146	1,381	1,673	19,59	2,267	2,584
July	4.01	1,242	1,497	1,813	2,123	2,457	2,801
August	3.86	1,196	1,441	1,745	2,043	2,365	2,696
September	2.76	855	1,031	1,248	1,461	1,691	1,928
October	3.17	982	1,184	1,433	1,678	1,942	2,214
November	2.53	784	945	1,144	1,339	1,550	1,767
December	1.69	524	631	764	895	1,035	1,180
Total	36.54	11,320	13,643	16,518	19,344	22,388	25,519
1-in-10							
January	1.36	421	508	615	720	833	950
February	1.59	493	594	719	842	974	1,110
March	3.85	1,193	1,438	1,740	2,038	2,359	2,689
April	4.86	1,506	1,815	2,197	2,573	2,978	3,394
May	5.18	1,605	1,934	2,342	2,742	3,174	3,618
June	4.73	1,465	1,766	2,138	2,504	2,898	3,303
July	4.67	1,447	1,744	2,111	2,472	2,861	3,261
August	4.24	1,314	1,583	1,917	2,245	2,598	2,961
September	3.20	991	1,195	1,447	1,694	1,961	2,235
October	3.38	1,047	1,262	1,528	1,789	2,071	2,361
November	2.70	836	1,008	1,221	1,429	1,654	1,886
December	1.85	573	691	836	979	1,134	1,292
Total	41.60	12,887	15,532	18,806	22,023	25,489	29,053

a. Acreage from **Table F-10**

Lee County Golf

The existing golf courses in Lee County are described in **Table F-12**. Lee County has experienced rapid growth in irrigated golf course acreage since the early 1960s. Lee County irrigated golf course acreage increased more than five-fold in between 1960 and 1970. Between 1970 and 1981 Lee County golf course acreage nearly tripled, and it again doubled during the 1980s. As in other counties, the growth in golf course acreage has occurred irregularly on a year-by-year basis.

Table F-12. Historic Irrigated Golf Course Acreage in Lee County.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Fort Myers Country Club	1918	120	120
Admiral Lehigh Acres	1960	115	235
Cypress Lake Country Club	1960	100	335
Cape Coral Golf Resort	1963	85	420
Lehigh Acres South (a.k.a. Mirror Lakes)	1967	160	580
Cape Coral Executive Golf Club	1968	20	600
El Rio Golf Club	1968	35	635
South Seas Plantation Golf Club	1969	75	710
Palmetto Pine Country Club	1970	95	805
Mirror Lakes	1970	160	965
Seven Lakes Country Club	1971	125	1,090
Lochmoor Country Club	1972	81	1,171
Myerlee Country Club	1972	15	1,186
San Carlos Golf and Country Club	1972	118	1,304
Bay Beach Golf Club	1973	29	1,333
Estero Woods Village	1975	6	1,339
The Landings Yacht and Golf Club (a.k.a. The Landing)	1975	150	1,489
Six Lakes	1975	43	1,532
Bonita Springs Golf and Country Club	1977	157	1,689
Beachview Golf Club	1978	70	1,759
Eastwood Golf Club	1978	100	1,859
Lake Lawn Country Club	1978	33	1,892
Spanish Wells Country Club	1979	90	1,982

Table F-12. (Continued) Historic Irrigated Golf Course Acreage in Lee County.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Forest Country Club	1980	160	2,242
Alden Pines Golf Club	1981	55	2,297
Burnt Store Marina	1981	170	2,651
Lake Fairways Country Club	1981	54	2,705
Cypress Pines Country Club	1982	89	2,794
Riverbend Golf Club (a.k.a. Riverbend East and West)	1982	60	2,854
The Dunes (a.k.a. Dunes Golf and Country Club)	1983	109	2,963
Euro American Investment	1983	122	3,085
Fiddlesticks Country Club	1983	266	3,351
Spring Creek	1983	321	3,672
Eagle Ridge Golf and Tennis Club	1984	68	3,740
Hideaway Beach Association (a.k.a. Hideaway Country Club)	1984	113	3,853
Bonita Bay Club	1985	121	3,974
Tara Woods	1985	4	3,978
Cross Creek Country Club	1985	62	4,040
Deer Run Golf Club	1985	77	4,117
Gasparilla Inn Golf Club	1985	30	4,147
Pine Lakes Country Club	1985	57	4,204
The Vines (a.k.a. The Vines Country Club)	1985	96	4,300
Terraverde Country Club	1985	12	4,312
Whiskey Creek Country Club	1985	51	4,363
Wildcat Run Country Club	1985	80	4,443
Bonita Fairways	1985	40	4,483
Golfview Golf and Racquet Club (a.k.a. Golfview)	1986	27	4,600
Pelican's Nest Golf Club	1986	204	4,804
Gulf Harbour Yacht and Country Club (a.k.a. River's Edge)	1986	205	5,009
Royal Tee	1986	146	5,155
Burnt Store Marina	1987	122	5,277
The Heritage	1987	26	5,303
Kelly Greens Golf and Country Club	1987	27	5,330

Table F-12. (Continued) Historic Irrigated Golf Course Acreage in Lee County.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Sabal Springs Golf and Racquet Club	1987	100	5,430
Coral Oaks Golf Club	1988	103	5,533
Country Creek Country Club (a.k.a. Village of Country Creek)	1988	167	5,700
Gateway Golf and Country Club	1988	148	5,848
Golf Villas of Bonita Springs	1988	2	5,850
Olde Hickory (a.k.a. Olde Hickory Golf and Country Club)	1989	97	5,947
Hunters Ridge Country Club	1989	112	6,059
Pelican Bay (Phase Two)	1989	55	6,114
Heron's Glen (a.k.a. Del Vera)	1991	180	6,294
Worthington Country Club	1991	120	6,414
Corkscrew Pines	1993	232	6,646
Sanctuary Golf Shop (a.k.a. The Sanctuary Golf Club)	1993	95	6,741
Huntington (a.k.a. Huntington Gold Course)	1995	41	6,782
Highland Woods	1995	272	7,054
The Colony at Pelican Landing (a.k.a. The Colony)	1995	300	7,354
Las Brias	1996	45	7,399
Westminster Golf Club	1996	120	7,519
Estero Point	1997	115	7,634
Brooks of Bonita Springs	1997	514	7,893
West Bay Golf Club	1999	100	9,007
Golf Club of Quincy	1999	120	9,127

The linear regression model discussed above assumes a constant change in the dependent variable for each one-unit change in one of the independent variables. When dealing with growth over time it is sometimes more appropriate to look at the percentage change over time. This type of a relationship can be modeled through the use of some form of logarithmic transformation. This type of a transformation can improve the specification of the model and reduce the problems created by serially correlated error terms in the absence of the log-transformed variable.

In **Equation F-14** below the following variables are included:

Cumacres = *cumulative irrigated Lee County golf course acres during a given year*

Year2 = *the numeric value of a given year*

D = *a zero-one dichotomous variable equal to zero prior to 1989 and one in 1989 and after*

Leepop = *Lee County population in a particular year as reported by BEBR (or the U. S/ Bureau of the Census in decennial years)*

Logpop = *the natural logarithm of Lee County population in a particular year.*

(F-14)

Multiple Regression Report

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Dependent cumacres

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	749497	104156.6	7.1959	0.000000	Reject Ho	1.000000
year2	-363.3705	53.28622	-6.8192	0.000000	Reject Ho	0.999999
D	-564.891	90.34115	-6.2529	0.000000	Reject Ho	0.999986
Leepop	7.495067E-02	5.002066E-03	14.9839	0.000000	Reject Ho	1.000000
Logpop	-3509.362	388.0309	-9.0440	0.000000	Reject Ho	1.000000
R-Squared	0.991309					

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.203081E+09	1.203081E+09			
Model	4	3.01956E+08	7.548901E+07	1739.3859	0.000000	1.000000
Error	61	2647388	43399.8			
Total(Adjusted)	65	3.046034E+08	4686206			

Root Mean Square Error	208.3262	R-Squared	0.9913
Mean of Dependent	4269.485	Adj R-Squared	0.9907
Coefficient of Variation	4.879422E-02	Press Value	3215654
Sum |Press Residuals|	11209.22	Press R-Squared	0.9894

Durbin-Watson Value 1.3032

Equation F-14 was used to develop the primary projection of irrigated golf course acreage in Lee County presented in **Table F-13**. The irrigation requirements in **Table F-14** were calculated by applying projected irrigated acreages to the supplemental water requirements (as calculated by the Blaney-Criddle permitting model). Input variables used are presented in **Table F-8**.

Table F-13. Total Projected Irrigated Golf Course Acreage for Lee County.

Year	Primary - 15%	Primary	Primary + 15%
1995	6,251	7,354[a]	8,457
1999	7,758	9,127[a]	10,496
2000	7,972	9,378	10,785
2005	8,951	10,531	12,110
2010	9,818	11,551	13,284
2015	11,391	13,401	15,411
2020	11,923	14,027	16,131

a. From **Table F-12**.

Table F-14. Irrigation Requirements for the Primary Golf Course Acreage Projections in Lee County.

Year		1995	2000	2005	2010	2015	2020
Lee County Acreage[a]		7,354	9,378	10,531	11,551	13,401	14,027
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.00	266	340	381	418	485	508
February	1.20	320	407	458	502	582	609
March	2.87	764	975	1,094	1,200	1,393	1,458
April	4.04	1,076	1,372	1,540	1,690	1,960	2,052
May	4.41	1,174	1,497	1,682	1,844	2,140	2,240
June	2.57	684	873	980	1,075	1,247	1,305
July	3.24	863	1,100	1,235	1,355	1,572	1,646
August	3.04	809	1,032	1,159	1,271	1,475	1,544
September	2.22	591	754	847	928	1,077	1,128
October	3.09	823	1,049	1,178	1,292	1,499	1,569
November	2.29	610	778	873	958	1,111	1,163
December	1.42	378	482	541	594	689	721
Total	31.39	8,358	10,659	11,969	13,129	15,231	15,943
1-in-10							
January	1.26	336	428	480	527	611	640
February	1.37	365	465	522	573	665	696
March	3.55	945	1,205	1,354	1,485	1,723	1,803
April	4.71	1,254	1,599	1,796	1,970	2,285	2,392
May	5.00	1,331	1,698	1,907	2,091	2,426	2,539
June	3.56	948	1,209	1,357	1,489	1,727	1,808
July	4.13	1,100	1,402	1,575	1,727	2,004	2,098
August	3.62	964	1,229	1,380	1,514	1,757	1,839
September	2.38	634	808	908	995	1,155	1,209
October	3.60	959	1,222	1,373	1,506	1,747	1,828
November	2.39	636	812	911	1,000	1,160	1,214
December	1.54	410	523	587	644	747	782
Total	37.12	9,884	12,604	14,154	15,525	18,011	18,853

a. Acreage from **Table F-13**.

Hendry Area Golf

In 1990, there were two golf courses in Hendry County and they are both located in the LWC Planning Area. These are described in **Table F-15**. No meaningful trend or explanatory model can be developed due to the small number of golf courses in the area. Therefore, projections must rely upon empirical knowledge of the golf industry in this area. The National Golf Foundation in Jupiter, which tracks the stage of development and location of all golf courses nationally, has no record of any golf course development presently occurring in the Hendry Area. Therefore, irrigated golf course acreage was projected to remain constant through the year 2020.

The irrigation requirements in **Table F-16** were calculated by applying the current irrigated acreage to the Blaney-Criddle permitting model. Input variables used are presented in **Table F-8**.

Table F-15. Golf Courses in the Hendry Area.

Golf Course	Year Golf Course Began Irrigating	Irrigated Acreage/ Golf Course	Cumulative Irrigated Acreage
Clewiston Golf Club	1959	62	62
Oxbow Golf Club at Port LaBelle	1974	240	190
Total		386	252

Table F-16. Irrigation Requirements for the Primary Golf Course Acreage Projections in the Hendry Area through the Year 2020.

Year	1995 through 2020			
Hendry County Acreage	252			
Hendry Area Acreage	252			
	1-in-2		1-in-10	
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)
January	0.93	9	1.16	11
February	1.15	10	1.30	12
March	2.62	24	3.41	31
April	3.68	34	4.38	40
May	4.12	38	4.65	42
June	2.54	23	3.44	31
July	3.39	31	3.94	36
August	3.30	30	3.55	32
September	2.84	26	3.40	31
October	2.84	26	3.26	30
November	2.11	19	2.05	19
December	1.25	11	1.17	11
Total	30.78	281	35.72	326

Glades Area Golf

Hendry Isles Resort is the only golf course in Glades County and it is in the LWC Planning Area. This golf course opened in 1978 and covers 72 acres, of which 20 acres are irrigated. No additional golf course development is anticipated through 2020 in the Glades Area. The existing acreage has 1-in-2 and 1-in-10 irrigation requirements of 33 MGY and 36 MGY, respectively.

Thermoelectric Power Generation Self-Supply

The LWC Planning Area has one thermoelectric power plant, located in Lee County. Thermoelectric power plants may withdraw large quantities of water for cooling purposes, but the vast majority of this water is not consumed. It is withdrawn from the Caloosahatchee and returned with some evaporative losses. In 1995, the demand for thermoelectric power from this plant was 281 MGY and it is expected to remain the same through 2020.

AGRICULTURAL DEMAND

Agricultural irrigation and cattle watering demand estimates were made by crop type for entire counties. Historical crop acreage data were gathered from the Florida Agricultural Statistics Service (FASS), Institute of Food and Agricultural Sciences (IFAS), Soil Conservation Service (SCS), Division of Plant Industry (DPI), Southwest Florida Water Management District (SWFWMD), and the District.

Agricultural water demand was projected for the LWC Planning Area by county or by county area. Agricultural irrigation and cattle watering demand estimates were made by time horizon (1995, 2000, 2005, 2010, 2015 and 2020) and by month. For all crop types in all areas, general methods were used to project acreage and determine irrigation requirements. Any methods specific to a crop type or an area are described in the corresponding section.

Acreage Projections

Crop acreage projections were needed for whole counties and for county portions (areas) within the LWC Planning areas. For the Hendry, Glades, and Collier areas, crop acreages were projected for the entire county and these projections apportioned. Unless inappropriate, this was done by assuming changes in acreage proportional to the most recently reported acreage ratios. Acreage ratios were developed from District land use maps and with the cooperation of the local Institute of Food and Agricultural Sciences (IFAS) extension offices. Land availability for the future growth of agriculture is examined in a general way based on District maps and data gathered from Comprehensive Plans.

The techniques chosen to project crop acreage were those that were judged to best reflect the specific crop scenario in each county. This led to some variation in projection techniques between crop types and between counties. While it would have been ideal if a comprehensive functional form could have been found which produced tangible projections universally, no such functional form was found. The acreage projections developed here reflect a combination of methods; each deemed appropriate where used. This is consistent with the method in which crop acreage is projected by IFAS and the other water management districts.

In some cases, a single mathematical model accurately explained past trends and generated a valid future projection. In other cases, several models accurately explained past trends and provided valid, though slightly differing, future projections. In these cases, the projections were averaged. This approach was justified by research performed at the BEBR (Mahmoud, 1984), which showed that taking the average of a number of different projections reduces the chances of making large errors and leads to more reliable projections.

If no statistically valid trend or any convincing empirical knowledge of future changes in a crop's acreage was found, the specific crop's acreage was projected at its most recently reported value for future time horizons. Usually these situations arose from relatively low quantity of water use for the crop type within the county or county area.

These projected crop acreages are consistent with the Caloosahatchee Water Management Plan. Apparent differences between the plans occur because of differences in geographic extents and the fact that the LWC Water Supply Plan uses net acres while the CWMP uses gross acres. Lands irrigated by ground water are consistent in both plans.

Projected land uses for 2020 are based on Florida Agricultural Statistics Service (FASS) data. FASS acreages are reported by whole county and the District then translates these reported acreages into the counties partially within the LWC Planning Region based on existing land use and water use permit data. For surface water irrigated lands in the Lake Okeechobee Service Area. The CWMP Advisory Committee recommended an increase beyond the projected acreage to reflect known agricultural plans, specifically for citrus and sugarcane. The additional citrus and sugarcane acreages were located primarily in western Hendry County.

Irrigation Requirements

Average (1-in-2) year and 1-in-10 drought year irrigation requirements were calculated using the District's modified Blaney-Criddle model. Modifications made to the Blaney-Criddle model are described in the District's Management of Water Use Permitting Information Manual Volume III (SFWMD, 1997).

Irrigation requirements are calculated by dividing the supplemental water requirement by the irrigation efficiency (**Equation F-15**). A crop's supplemental water requirement is the amount of water used for evapotranspiration minus effective rainfall,

while irrigation requirement includes both the supplemental water requirement and the losses incurred in getting irrigation to the crop's root zone. Irrigation efficiency refers to the average percent of total water applied that is stored in the plant's root zone. The irrigation requirement equation is as follows:

Irrigation requirement = Supplemental water requirement / Irrigation efficiency *(F-15)*

Supplemental water requirement = Water used for evapotranspiration - effective rainfall *(F-16)*

Projections of irrigation system type, and the effect of the corresponding irrigation efficiencies, were based on the interpretation of current ratios and trends. Three basic types of irrigation systems are currently being used in crop production in the LWC Planning Area: seepage, overhead sprinkler, and micro irrigation systems. The irrigation efficiencies estimated by the District for these systems are 50, 75, and 85 percent, respectively.

Irrigation efficiency depends, in part, on soil type. Soil type, with regard to water use permitting by the District, refers to the soil's usable, water holding capacity. Usable soil water holding capacity has a direct affect on the fraction of rainfall or irrigation that is effective. The District classifies five types of soil with regard to water holding capacity in inches per foot. These holding capacities are 0.4, 0.8, 1.5, and 3.6 inches per foot. Soil types in the county areas of LWC Planning Area are shown in **Figure F-1** (SFWMD, 1985).

Unless otherwise specified, a crops entire acreage was treated as if all took place on the most common soil type permitted for that crop in the respective county. Likewise, unless otherwise stated, the historical weather data from the rainfall station most frequently used to permit allocations for that crop in the respective county is used.

Inputs used to determine irrigation requirements for each crop type within each county or county area are listed in **Table F-17**.

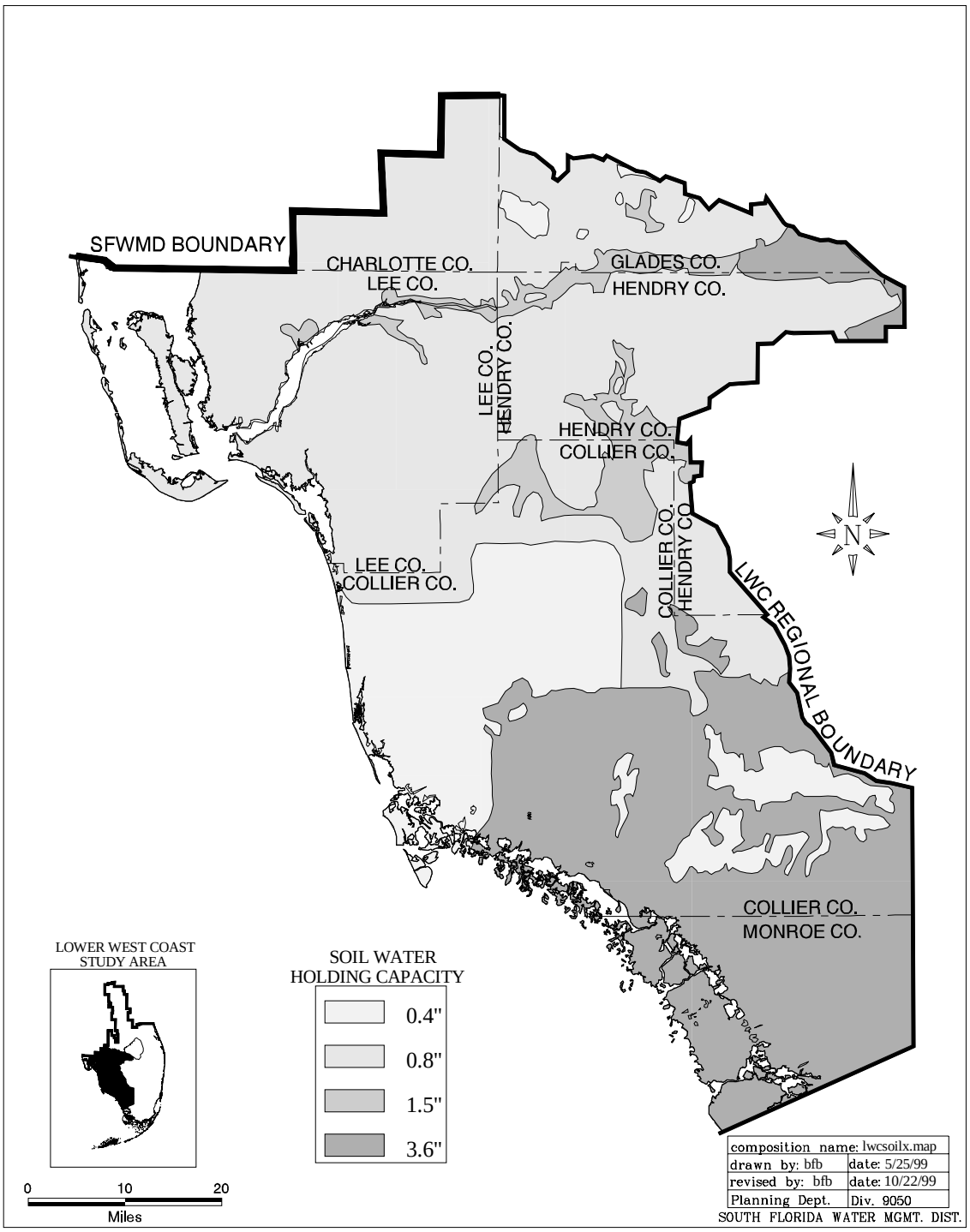

Figure F-1. Soil Types in the Lower West Coast Planning Area.

Table F-17. Inputs Used to Determine Irrigation Requirements.

Crop Type	Irrigation System			Soil	Rainfall Station
	Type	Used By	Efficiency		
Collier County					
Citrus	micro irrigation	72%	85%	sandy soil with 0.8 inch usable soil water capacity/ft.	Immokalee
	overhead sprinkler	4%	75%		
	seepage	24%	50%		
Vegetables	seepage	100%	50%		
Ornamental Nursery	overhead sprinkler (with containerized plants)	100%	50%		Naples
Lee County					
Citrus	micro irrigation	50%	85%	sandy soil with 0.8 inch usable soil water capacity/ft.	Fort Myers
	seepage	50%	50%		
Tropical Fruit	seepage	100%	50%		
Vegetables	seepage	100%	50%		
Sod	seepage	100%	50%		
Ornamental Nursery	overhead sprinkler (with containerized plants)	100%	50%		
Hendry County					
Citrus	micro irrigation	60%	85%	sandy soil with 0.8 inch usable soil water capacity/ft.	LaBelle
	overhead sprinkler	4%	75%		
	seepage	36%	50%		
Field Crops	seepage	100%	50%		
Vegetables	seepage	100%	50%		
Sod	seepage	100%	50%		
Cut Flowers	seepage	100%	50%		
Ornamental Nursery	overhead sprinkler (with containerized plants)	100%	50%		
Glades County					
Citrus	micro irrigation	77%	85%	sandy soil with 0.8 inch usable soil water capacity/ft.	Moore Haven
	overhead sprinkler	3%	75%		
	seepage	20%	50%		
Field Crops	seepage	100%	50%		
Vegetables	seepage	100%	50%		
Ornamental Nursery	overhead sprinkler (with containerized plants)	100%	50%		
Charlotte County					
Citrus	micro irrigation	100%	85%	soil type of 0.8 inch usable soil water capacity/ft.	LaBelle
Field Crops	seepage	100%	50%		
Vegetables	seepage	100%	50%		

Crop Types

Irrigated commercially grown crop categories are based on the categories developed by the Water Demand Projection Subcommittee, which was made up of representatives from Florida's five water management districts. These categories are citrus, other fruits and nuts, vegetables, melons and berries, field crops, greenhouse/ nursery, sod, pasture, and miscellaneous. The crops within these categories are shown in **Table F-18**. Although all of these crops are grown commercially somewhere within the Florida, not all are grown within the LWC Planning Area. In the LWC Planning Area the commercially grown crops are citrus, field crops (mainly sugarcane), tropical fruit, vegetables, sod, cut flowers, and ornamental nursery plants. Pasture is almost never irrigated. However, there are some demands for cattle watering.

Table F-18. Agricultural Crop Categories.

Citrus (all irrigated crops)		**Field Crops**	
Other Fruits and Nuts		Corn	Sorghum
Avocados	Papaya	Cotton	Soybean
Mangos	Peaches	Hay	Sugarcane
	Pecans	Peanuts	Tobacco
		Rice	Wheat
			Others
Vegetables, Melons, and Berries		**Greenhouse/Nursery**	
Aromatic Vegetables	Escarole	Floriculture	
Beans	Green Peppers	Fern	
Blueberries	Latin Vegetables	Other Ornamentals	
Cabbage	Lettuce	**Sod**	
Cantaloupe	Potatoes	**Pasture**	
Carrots	Squash	**Miscellaneous**	
Celery	Strawberries	Agriculture	Cattle
Chinese Vegetables	Sweet Corn	Aquaculture	Dairy
Cucumbers	Tomatoes		Poultry
Eggplant	Watermelons		Others

Citrus

All categories of citrus (oranges, grapefruit, tangerines, etc.) were grouped together for projection purposes. Historical citrus acreage data were gathered from volumes of the Commercial Citrus Inventory, which is published biennially by FASS. The historical projections, presented in the tables, are net acres based on FASS information. During the development of the CWMP additional citrus acres were added to these projections. Based on local knowledge provided by agricultural interests on the CWMP Advisory Committee, an additional 12,748 gross acres of citrus were added to these projections. These 12,748 gross acres were combined with the converted historical projection net acreages resulting in a total of 125,035 gross acres of citrus in the Caloosahatchee Basin for the 2020 demand projections for modeling purposes.

The citrus planting rates in the LWC Planning Area were at historically high levels from 1986 to 1994. Following several freezes in Central Florida during the 1980s citrus production moved from central to southwest Florida. High returns further increased citrus planting rates. Since 1994, citrus acreage has levelled out.

Previous citrus acreage projections based on information through 1990 for Lee and Hendry counties represented an extrapolation of the medium planting rate scenario for years after 1990 as outlined by Behr et. al (1988). Developments since 1994 indicate that the Behr's medium planting rate has not been realized since 1994. Forecasting equations are presented for Glades, Charlotte, and Collier counties, where recent growth has not been as extreme. Hendry is the only county in the LWC Planning Area with significant citrus nursery acreage and these irrigation requirements are projected separately.

Three types of systems are used to irrigate citrus crops in the LWC Planning Area: micro irrigation, overhead sprinklers, and seepage (**Table F-17**). District permits were used to determine the ratio of acreage being irrigated by these system in 1990. In recent years, micro irrigation has been the system of choice on new citrus groves. It costs less than overhead sprinkler systems and results in higher productivity than seepage systems. However, there is still a substantial citrus acreage in the LWC Planning Area with seepage irrigation, and to a lesser extent, overhead sprinkler irrigation. This ratio was applied to the acreage for 1990 and the corresponding application efficiencies used to calculate irrigation requirements. All citrus planted after 1995 was assumed to have some form of micro irrigation.

Collier County Citrus

Historical citrus acreage in Collier County is presented in **Table F-19**. Collier County citrus acreage was projected using variants of a generic model shown in **Equation F-17**, which has been used by District analysts for projecting citrus acreage in a variety of planning efforts.

Table F-19. Historic Citrus Acreage in Collier County.

Year	Historic	Year	Historic
1966	2,605	1984	8,425
1968	3,933	1986	10,063
1970	5,052	1988	17,309
1972	5,228	1990	23,565
1974	5,474	1992	34,167
1976	5,396	1994	36,534
1978	5,975	1995	36,559[a]
1980	6,706	1996	36,583
1982	7,931	1998	36,655

a. The 1995 acreage is estimated by interpolating between the 1994 and 1996 acreages.

$$COLCIT_t = f(time, D, RP_p, RP_w, RP_o) \quad (F\text{-}17)$$

where:

$COLCIT_t$ = *Citrus acreage in Collier County in year t*

RP_p, RP_w, RP_o = *The real season average prices of interior region pink and white grapefruit and oranges*

D = *a dichotomous variable equal to zero before 1992 and equal to one from 1992 to the present.*

The dichotomous variable corresponds to the slowing of the rapid citrus growth period in the LWC Planning Area. Models were run which weighted all observations equally and with the weight assigned to a particular observation declining geometrically with time, with the lowest weight being assigned to the earliest observation. Weighted Collier citrus acreage is denoted as $WTCOLCIT_t$. Eight specific submodels were estimated as shown in **Equations F-18** through **F-25**.

$$COLCIT_t = f(time, RP_p, RP_w, RP_o, D) \quad (F\text{-}18)$$

$$WTCOLCIT_t = f(time, RP_p, RP_w, RP_o, D) \quad (F\text{-}19)$$

$$COLCIT_t = f(time, D) \quad (F\text{-}20)$$

$$WTCOLCIT_t = f(time, D) \quad (F\text{-}21)$$

$$COLCIT_t = f(time, RP_p, RP_o, RP_w) \quad (F\text{-}22)$$

$$WTCOLCIT_t = f(time, RP_p, RP_w, RP_o) \quad (F\text{-}23)$$

$$COLCIT_t = f(time) \quad (F\text{-}24)$$

$$WTCOLCIT_t = f(time) \quad (F\text{-}25)$$

Historic data from 1966 through 1996 were used to estimate **Equations F-18** through **F-25**. To generate the primary projection the estimates derived from these equations were averaged. Then the residual for 1996 was added to the projection for 1996 to force the observed and the projected acreages to be equal. A residual is the difference between the averaged estimates and the observed acreage.

Projected acreage for 1998 through 2020 were derived using the methods described above. The primary, primary minus 15 percent, and primary plus 15 percent projected acreages are presented in **Table F-20**.

Table F-20. Projected Citrus Acreage in Collier County.

Year	Primary - 15%	Primary	Primary + 15%
1995	31,075	36,559[a]	42,043
1998	31,157	36,655[a]	42,153
2000	33,924	39,911	45,898
2005	31,736	37,336	42,936
2010	40,747	47,938	55,129
2015	44,159	51,952	59,745
2020	47,571	55,966	64,361

a. From **Table F-19**.

The 1-in-2 (average) and 1-in-10 supplemental water requirements are shown in **Table F-21.** The supplemental water requirements were divided by irrigation application efficiency to yield 1-in-2 and 1-in-10 irrigation requirements (**Equation F-15**). For the calculation of irrigation requirements, data from the Immokalee rainfall station, soil with a water holding capacity of 0.8 in./ft., and the 1990 ratio of permitted irrigation systems were used (**Table F-17**). In 1990, 72 percent of the permitted citrus acreage in Collier County used micro irrigation, 24 percent used seepage, and 4 percent used overhead sprinklers.

Table F-21. Irrigation Requirements for the Primary Citrus Acreage Projections in Collier County.

Year		1995	2000	2005	2010	2015	2020
Collier County Acreage[a]		36,559	39,911	43,924	47,938	51,952	55,966
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.32	1,542	1,683	1,852	2,022	2,191	2,360
February	1.43	1,659	1,811	1,993	2,175	2,357	2,539
March	2.40	2,803	3,060	3,368	3,676	3,983	4,291
April	3.11	3,632	3,966	4,364	4,763	5,162	5,561
May	3.08	3,597	3,927	4,322	4,717	5,112	5,507
June	1.46	1,705	1,862	2,049	2,236	2,423	2,611
July	2.25	2,628	2,869	3,157	3,446	3,734	4,023
August	2.21	2,581	2,818	3,101	3,385	3,668	3,952
September	1.87	2,184	2,384	2,624	2,864	3,104	3,344
October	2.64	3,084	3,366	3,705	4,043	4,382	4,720
November	2.00	2,336	2,550	2,807	3,063	3,320	3,576
December	1.67	1,951	2,129	2,344	2,558	2,772	2,986
Total	25.44	29,714	32,438	35,700	38,962	42,225	45,487
1-in-10							
January	1.45	1,694	1,849	2,035	2,221	2,407	2,593
February	1.74	2,032	2,219	2,442	2,665	2,888	3,111
March	3.16	3,691	4,029	4,434	4,840	5,245	5,650
April	3.78	4,415	4,820	5,304	5,789	6,274	6,759
May	3.87	4,520	4,935	5,431	5,927	6,423	6,920
June	2.06	2,406	2,627	2,891	3,155	3,419	3,683
July	2.62	3,060	3,341	3,677	4,013	4,349	4,685
August	2.59	3,025	3,302	3,635	3,967	4,299	4,631
September	2.38	2,780	3,035	3,340	3,645	3,950	4,255
October	3.25	3,796	4,144	4,561	4,977	5,394	5,811
November	2.16	2,523	2,754	3,031	3,308	3,585	3,862
December	1.81	2,114	2,308	2,540	2,772	3,004	3,236
Total	30.86	36,044	39,349	43,306	47,263	51,221	55,178

a. Acreage from **Table F-20**.

Lee County Citrus

Table F-22 presents historical citrus acreage in Lee County. The projected citrus acreage for Lee County presented in **Table F-23** were determined using a medium planting rate scenario as outlined by Behr et. al (1988) which developed three scenarios for future citrus planting rates (high, medium, and low). The medium growth rate represents additional growth at half the rate experienced between 1986 and 1988.

Table F-22. Historic Citrus Acreage in Lee County.

Year	Historic	Year	Historic
1966	195	1984	6,575
1968	743	1986	7,313
1970	5,427	1988	8,247
1972	7,290	1990	9,692
1974	7,397	1992	10,559
1976	6,243	1994	12,238
1978	5,384	1995	12,197[a]
1980	5,139	1996	12,155
1982	4,787	1998	11,871

a. The 1995 acreage is estimated by interpolating between the 1994 and 1996 acreages.

Table F-23. Projected Citrus Acreage in Lee County.

Year	Primary - 15%	Primary	Primary + 15%
1995	10,367	12,197[a]	14,027
1998	10,090	11,871[a]	13,652
2000	10,010	11,777	13,544
2005	10,940	12,870	14,800
2010	11,869	13,964	16,059
2015	12,798	15,057	17,316
2020	13,728	16,150	16,573

a. From **Table F-22**.

The 1-in-2 and 1-in-10 supplemental water requirements for citrus were divided by irrigation application efficiency to yield irrigation requirements (**Table F-24**). For the calculation of irrigation requirements, data from the Fort Myers rainfall station, soil with a water holding capacity of 0.8 in./ft., and the 1990 ratio of permitted irrigation systems were used (**Table F-17**). In 1990, 50 percent of the permitted citrus acreage in Lee County was irrigated using micro irrigation and 50 percent was irrigated using seepage irrigation.

Table F-24. Irrigation Requirements for the Primary Citrus Acreage Projections in Lee County.

Year		1995	2000	2005	2010	2015	2020
Lee County Acreage[a]		12,197	11,777	12,870	13,964	15,057	16,150
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.51	588	568	621	674	726	779
February	1.53	596	576	629	683	736	789
March	2.63	1,025	990	1,081	1,173	1,265	1,357
April	3.20	1,247	1,204	1,316	1,428	1,539	1,651
May	3.17	1,235	1,193	1,303	1,414	1,525	1,636
June	1.31	510	493	539	584	630	676
July	1.88	733	707	773	839	904	970
August	1.77	690	666	728	790	851	913
September	1.25	487	470	514	558	601	645
October	2.48	966	933	1,020	1,106	1,193	1,280
November	2.29	892	862	942	1,022	1,102	1,182
December	1.76	686	662	724	785	847	908
Total	24.77	9,652	9,320	10,185	11,051	11,915	12,780
1-in-10							
January	1.77	690	666	728	790	851	913
February	1.69	659	636	695	754	813	872
March	3.30	1,286	1,242	1,357	1,472	1,587	1,703
April	3.83	1,492	1,441	1,575	1,709	1,842	1,976
May	3.72	1,450	1,400	1,530	1,660	1,789	1,919
June	2.21	861	832	909	986	1,063	1,140
July	2.69	1,048	1,012	1,106	1,200	1,294	1,388
August	2.30	896	865	946	1,026	1,106	1,187
September	1.40	546	527	576	625	673	722
October	2.97	1,157	1,117	1,221	1,325	1,429	1,532
November	2.39	931	899	983	1,066	1,150	1,233
December	1.88	733	707	773	839	904	970
Total	30.16	11,753	11,348	12,401	13,455	14,508	15,561

a. Acreage from **Table F-23**.

Hendry Area Citrus

Table F-25 presents the historical citrus acreage for all of Hendry County. **Table F-26** presents projections for the whole county derived from a medium planting scenario as outlined by Behr et. al (1988). Seventy-two percent of the Hendry County citrus acreage is within the LWC Planning Area. This percentage was applied to the county projections to obtain the Hendry Area citrus acreage projections which are also presented in **Table F-26**.

Table F-25. Historic Citrus Acreage in Hendry County.

Year	Historic	Year	Historic
1966	16,152	1984	36,807
1968	19,988	1986	40,269
1970	22,447	1988	54,957
1972	22,684	1990	73,754
1974	24,225	1992	87,396
1976	25,944	1994	98,604
1978	28,903	1995	99,187[a]
1980	30,086	1996	99,770
1982	32,944	1998	100,124

a. The 1995 acreage is estimated by interpolating between the 1994 and 1996 acreages.

Table F-26. Projected Citrus Acreage in Hendry County and the Hendry Area.

Year	Hendry County			Hendry Area		
	Primary - 15%	Primary	Primary + 15%	Primary - 15%	Primary	Primary + 15%
1995	84,309	99,187[a]	114,065	60,703	71,415	82,127
1998	85,105	100,124[a]	115,143	61,276	72,089	82,903
2000	87,424	102,852	118,280	62,945	74,053	85,161
2005	89,743	105,580	121,417	64,615	76,018	87,420
2010	92,062	108,308	124,554	66,284	77,982	89,679
2015	94,381	111,036	127,691	67,954	79,946	91,938
2020	96,698	113,762	130,826	69,622	81,909[b]	94,195

a. From **Table F-25**.
b. An additional 12,748 gross acres of citrus were added for modeling purposes resulting in a total of 125,035 gross acres in the Caloosahatchee basin. To prevent misrepresentation, gross acreages and net acreages are not combined in this table.

The supplemental water requirements were divided by irrigation application efficiency to yield the irrigation requirements for the Hendry Area citrus (**Equation F-15**). These are presented in **Table F-27** for both a 1-in-2 year and a 1-in-10 drought year. For the calculation of irrigation requirements, data from the LaBelle rainfall station, soil with a water holding capacity of 0.8 in./ft., and the 1990 ratio of permitted irrigation systems were used (**Table F-17**). In 1990, the ratio of irrigation systems used on permitted citrus acreage in Hendry County was 60 percent micro irrigation, 36 percent seepage, and 4 percent overhead sprinklers.

Table F-27. Irrigation Requirements for the Primary Citrus Acreage Projections in the Hendry Area.

Year		1995	2000	2005	2010	2015	2020
Hendry County Acreage[a]		99,187	102,852	105,580	108,308	111,036	113,762
Hendry Area Acreage[a]		71,415	74,053	76,018	77,982	79,946	81,909
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	0.90	2,053	2,129	2,186	2,242	2,299	2,355
February	1.08	2,464	2,555	2,623	2,691	2,758	2,826
March	2.43	5,544	5,749	5,902	6,054	6,207	6,359
April	3.38	7,712	7,997	8,209	8,421	8,633	8,845
May	3.74	8,533	8,848	9,083	9,318	9,552	9,787
June	2.27	5,179	5,371	5,513	5,655	5,798	5,940
July	3.17	7,233	7,500	7,699	7,898	8,097	8,295
August	3.10	7,073	7,334	7,529	7,723	7,918	8,112
September	2.68	6,115	6,341	6,509	6,677	6,845	7,013
October	2.76	6,297	6,530	6,703	6,876	7,049	7,222
November	2.28	5,202	5,394	5,537	5,680	5,823	5,966
December	1.57	3,582	3,714	3,813	3,911	4,010	4,108
Total	29.27	66,782	69,249	71,086	72,923	74,759	76,595
1-in-10							
January	1.12	2,555	2,650	2,720	2,790	2,861	2,931
February	1.56	3,559	3,691	3,789	3,887	3,984	4,082
March	3.21	7,324	7,594	7,796	7,997	8,199	8,400
April	4.06	9,263	9,605	9,860	10,115	10,370	10,624
May	4.25	9,697	10,055	10,322	10,588	10,855	11,122
June	3.15	7,187	7,453	7,650	7,848	8,046	8,243
July	3.71	8,465	8,777	9,010	9,243	9,476	9,708
August	3.34	7,620	7,902	8,112	8,321	8,531	8,740
September	3.24	7,392	7,665	7,869	8,072	8,275	8,479
October	3.18	7,255	7,523	7,723	7,923	8,122	8,322
November	1.23	2,806	2,910	2,987	3,064	3,142	3,219
December	1.49	3,400	3,525	3,619	3,712	3,806	3,899
Total	34.23	78,098	80,984	83,132	85,280	87,428	89,574

a. Acreage is from **Table F-26**.

Hendry Area Citrus Nurseries

The only portion of the LWC Planning Area which has significant citrus nursery acreage is the Hendry Area. Citrus nursery acreage in the Hendry Area has been quite volatile, with acreage generally responding to the same types of factors as influence citrus acreage. Given the volatility in historic citrus nursery acreage in the Hendry Area and the recent slow down in citrus acreage growth, the decision was made to hold citrus nursery acreage at its 1995 level, which is approximately 145 acres. The estimated irrigation requirements for citrus nursery acreage in the Hendry Area is 160.1 MGY.

Glades Area Citrus

The same eight generic models, described for Collier County in **Equations F-18** through **F-25**, were run for Glades County. On the basis of statistical goodness-of-fit criteria an equation of the form of **Equation F-21** was selected. The results are shown in **Equation F-26**. The independent variables included in **Equation F-21** below are as follows:

TIME = *one in 1966 and increases by one unit per year thereafter*

D_3 = *a dichotomous variable equal to zero prior to 1980 and one in 1980 and thereafter*

The dichotomous variable corresponds fairly closely to the onset of the series of severe winters, so the D variable picks up a portion of the interregional shift in citrus production within Florida associated with severe winters in the mid-1980's.

Equation F-26 was estimated using weighted least squares, with the highest weight being assigned to the most recent year for which data was available and with weights declining geometrically with time.

The logic of this formulation is that Lee County citrus acreage was almost flat from 1966 to 1978; the weighting method selected applies the greatest weight to the most recent data. Weighted regression was selected to account for the observed heteroscedasticity of the Glades County citrus data.

Historical citrus acreage in Glades County are presented in **Table F-28**. When projections were made using **Equation F-26**, adjusted to pass through the 1998 historic citrus acreage, the results shown in **Table F-29** were obtained. Fifty-two percent of the Glades County citrus acreage is within the LWC Planning Area. This percentage was applied to the county projections to obtain the Glades Area citrus acreage projections (**Table F-29**).

Table F-28. Historic Citrus Acreage in Glades County.

Year	Historic	Year	Historic
1966	1,413	1984	5,141
1968	1,461	1986	6,076
1970	1,572	1988	6,235
1972	1,639	1990	7,523
1974	1,661	1992	9,136
1976	1,615	1994	9,270
1978	1,613	1995	9,336
1980	3,395	1996	9,402
1982	4,026	1998	10,776

(F-26)

Multiple Regression Report

Page/Date/Time	1 07-07-1999 16:05:47
Database	C:\My Documents\DATA\Wumps\Citrus\Glacit.S0
Dependent	GLACIT
Weight	WEIGHT

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	-1254.708	554.5659	-2.2625	0.040097	Reject Ho	0.558103
TIME	330.5913	30.05212	11.0006	0.000000	Reject Ho	1.000000
D3	969.9697	488.3197	1.9863	0.066932	Accept Ho	0.456211
R-Squared	0.968245					

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	-1254.708	554.5659	-2444.133	-65.28213	0.0000
TIME	330.5913	30.05212	266.1359	395.0467	0.8570
D3	969.9697	488.3197	-77.37193	2017.311	0.1547
T-Critical	2.144787				

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	3.855331E+08	3.855331E+08			
Model	2	8.089883E+07	4.044942E+07	213.4407	0.000000	1.000000
Error	14	2653158	189511.3			
Total(Adjusted)	16	8.355199E+07	5222000			

Root Mean Square Error	435.3289	R-Squared	0.9682
Mean of Dependent	6634.969	Adj R-Squared	0.9637
Coefficient of Variation	0.0656113	Press Value	2.128602E+08
Sum |Press Residuals|	23896.56	Press R-Squared	-1.5476

Normality Tests Section

Assumption	Value	Probability	Decision(5%)
Skewness	2.4418	0.014614	Rejected
Kurtosis	1.5161	0.129494	Accepted
Omnibus	8.2609	0.016075	Rejected

Serial-Correlation Section

Lag	Correlation	Lag	Correlation	Lag	Correlation
1	0.603577	9	0.132122	17	
2	0.263842	10	0.129558	18	
3	-0.028691	11	0.078291	19	
4	-0.277835	12	0.119781	20	
5	-0.394043	13	0.037731	21	
6	-0.358361	14	-0.061802	22	
7	-0.130131	15	-0.075028	23	
8	-0.031908	16	0.025211	24	

Above serial correlations significant if their absolute values are greater than 0.485071

Durbin-Watson Value 0.8865

Table F-29. Projected Citrus Acreage in Glades County and the Glades Area.

Year	Glades County			Glades Area		
	Primary - 15%	Primary	Primary + 15%	Primary - 15%	Primary	Primary + 15%
1995	7,936	9,336[a]	10,736	4,127	4,855	5,583
1998	9,160	10,777[a]	12,393	4,763	5,604	6,444
2000	9,554	11,240	12,926	4,968	5,845	6,722
2005	10,542	12,402	14,262	5,482	6,449	7,417
2010	11,529	13,563	15,598	5,995	7,053	8,111
2015	12,516	14,725	16,934	6,509	7,657	8,806
2020	13,504	15,877	18,270	7,022	8,261	9,501

a. From **Table F-28**.

The supplemental water requirements were divided by irrigation application efficiency to yield the irrigation requirements for the Glades Area citrus (**Equation F-15**). These are presented in **Table F-27** for both a 1-in-2 year and a 1-in-10 drought year. For the calculation of irrigation requirements, data from the Moore Haven rainfall station, soil with a water holding capacity of 0.8 in./ft., and micro irrigation estimated application efficiency were used (**Table F-17**). Although a sizeable acreage of citrus in the Glades Area has not converted to micro irrigation, the decision was made to estimate irrigation requirements based on the micro irrigation system efficiencies. This was done because micro irrigation is becoming the standard irrigation system in the area. Although existing permit allocations will be recognized, for long range planning purposes it is deemed desirable to plan for micro irrigation efficiencies.

Table F-30. Irrigation Requirements for the Primary Citrus Acreage Projections in the Glades Area.

Year		1995	2000	2005	2010	2015	2020
Glades County Acreage[a]		9,336	11,240	12,402	13,563	14,725	15,887
Glades Area Acreage[a]		4,855	5,845	6,449	7,053	7,657	8,261
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.45	225	271	299	327	355	383
February	1.46	226	273	301	329	357	385
March	2.38	369	444	490	536	582	628
April	2.86	444	534	589	644	700	755
May	2.92	453	545	602	658	714	771
June	1.97	306	368	406	444	482	520
July	2.46	382	459	507	554	602	649
August	2.47	383	461	509	557	604	652
September	1.75	271	327	361	394	428	462
October	2.44	379	456	503	550	597	644
November	2.13	330	398	439	480	521	562
December	1.65	256	308	340	372	404	435
Total	25.92	4,020	4,840	5,340	5,840	6,341	6,841
1-in-10							
January	1.62	251	303	334	365	396	428
February	1.58	245	295	326	356	387	417
March	3.09	479	577	637	696	756	816
April	3.47	538	648	715	782	849	916
May	3.56	552	665	733	802	871	940
June	2.83	439	528	583	638	692	747
July	3.11	483	581	641	701	761	821
August	2.73	423	510	562	615	668	721
September	2.16	335	403	445	487	528	570
October	2.92	453	545	602	658	714	771
November	2.19	340	409	451	493	536	578
December	1.78	276	332	367	401	435	470
Total	31.04	4,814	5,796	6,395	6,994	7,593	8,192

a. Acreage is from **Table F-29**.

Charlotte Area Citrus

Historic citrus acreage within Charlotte County is presented in **Table F-31**.

Table F-31. Historic Citrus Acreage in Charlotte County.

Year	Historic	Year	Historic
1966	5,048	1984	8,220
1968	6,052	1986	8,759
1970	6,734	1988	9,345
1972	6,640	1990	11,718
1974	6,549	1992	15,981
1976	6,408	1995	20,589
1978	6,100	1994	19,995
1980	6,122	1996	21,183
1982	6,120	1998	21,522

A variety of variables and functional forms were tested, and models of the general form of **Equation F-17** were found to best explain past trends in citrus acreage in Charlotte County, as was the case for Collier and Glades Counties. The dichotomous variable D was assigned as follows:

D = a dichotomous variable equal to zero before 1984 and equal to one from 1984 to the present

The dichotomous variable corresponds fairly closely to the onset of the series of severe winters, so the D variable picks up a portion of the interregional shift in citrus production within Florida associated with these severe winters. On the basis of these goodness-of-fit statistics, **Equation F-27** was estimated, based on functional form **Equation F-22**. The independent variables included in **Equation F-27** are as follows:

TIME = one in 1966 and increases by one unit per year thereafte

WHITEINT= the real price of white interior region grapefruit

REALO = the real average price of all oranges

PINKINT = the real price of pink interior region grapefruit

D = a dichotomous variable equal to zero prior to 1994 and one in 1994 and thereafter

Equation F-27 was estimated using weighted least squares, with the highest weight being assigned to the most recent year for which data was available and with weights declining geometrically with time. Like Glades County, Charlotte County experienced little growth in citrus acreage between 1966 and 1980.

Equation F-27 was utilized to project the Charlotte County citrus acreage (**Table F-32**). The percent of Charlotte County citrus acreage located within the Charlotte Area is 15 percent. To obtain projected citrus acreage for the Charlotte Area, the projected acreage for the county was multiplied by 15 percent (**Table F-32**).

(F-27)

Multiple Regression Report

Page/Date/Time	1 04-12-1999 09:46:17
Database	C:\My Documents\LWCWSP\charcit.S0
Dependent	CHARCIT
Weight	Weight

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	-3211.662	4456.808	-0.7206	0.486176	Accept Ho	0.101141
TIME	327.2331	66.86897	4.8936	0.000476	Reject Ho	0.993309
WHITEINT	-965.6926	397.4951	-2.4294	0.033443	Reject Ho	0.600533
REALO	-116.0678	392.6572	-0.2956	0.773044	Accept Ho	0.058438
PINKINT	2189.808	728.2482	3.0070	0.011931	Reject Ho	0.781452
D	12799.77	2703.675	4.7342	0.000615	Reject Ho	0.990115
R-Squared	0.979194					

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	-3211.662	4456.808	-13021.03	6597.706	0.0000
TIME	327.2331	66.86897	180.0555	474.4107	0.4254
WHITEINT	-965.6926	397.4951	-1840.573	-90.81165	-0.3170
REALO	-116.0678	392.6572	-980.3005	748.1649	-0.0340
PINKINT	2189.808	728.2482	586.9443	3792.671	0.6442
D	12799.77	2703.675	6849.025	18750.52	0.9709
T-Critical	2.200985				

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	1.46212E+09	1.46212E+09			
Model	5	3.252992E+08	6.505985E+07	103.5408	0.000000	0.999999
Error	11	6911849	628349.9			
Total(Adjusted)	16	3.322111E+08	2.076319E+07			

Root Mean Square Error	792.6852	R-Squared	0.9792
Mean of Dependent	12921.1	Adj R-Squared	0.9697
Coefficient of Variation	6.134812E-02	Press Value	8.534025E+07
Sum |Press Residuals|	19920.97	Press R-Squared	0.7431

The 1-in-2 (average) and 1-in-10 supplemental water requirements for the Charlotte Area are shown in **Table F-33.** The supplemental water requirements were divided by irrigation application efficiency to yield 1-in-2 and 1-in-10 irrigation requirements (**Equation F-15**). For the calculation of irrigation requirements, data from the LaBelle rainfall station, soil with a water holding capacity of 0.8 in./ft., and the

estimated application efficiency of micro irrigation were used (**Table F-17**). All citrus permitted by the District in August 1990 in the Charlotte Area had micro irrigation and all future citrus is expected to be irrigated with similar systems.

Table F-32. Projected Citrus Acreage in Charlotte County and the Charlotte Area.

Year	Charlotte County			Charlotte Area		
	Primary - 15%	Primary	Primary + 15%	Primary - 15%	Primary	Primary + 15%
1995	17,501	20,589[a]	23,677	2,625	3,088	3,551
1998	18,294	21,522[a]	24,750	2,744	3,228	3,713
2000	18,850	22,176	25,503	2,827	3,326	3,825
2005	20,241	23,813	27,385	3,036	3,572	4,108
2010	21,631	25,449	29,266	3,245	3,817	4,390
2015	23,022	27,085	31,148	3,453	4,063	4,672
2020	24,413	28,721	33,029	3,662	4,308	4,954

a. From **Table F-31**.

Table F-33. Irrigation Requirements for the Primary Citrus Acreage Projections in the Charlotte Area.

Year		1995	2000	2005	2010	2015	2020
Charlotte County Acreage[a]		20,589	22,176	23,813	25,449	27,085	28,721
Charlotte Area Acreage		3,088	3,326	3,572	3,817	4,063	4,308
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**					
1-in-2							
January	1.43	141	152	163	174	186	197
February	1.47	145	156	168	179	191	202
March	2.39	236	254	273	291	310	329
April	2.86	282	304	326	349	371	394
May	2.91	287	309	332	355	378	401
June	1.29	127	137	147	157	167	178
July	2.03	200	216	232	248	264	279
August	2.02	199	215	231	246	262	278
September	1.84	182	196	210	224	239	253
October	2.24	221	238	256	273	291	308
November	2.11	208	224	241	257	274	290
December	1.58	156	168	180	193	205	217
Total	24.17	2,396	2,581	2,772	2,962	3,153	3,343
1-in-10							
January	1.67	165	177	191	204	217	230
February	1.62	160	172	185	198	210	223
March	3.16	312	336	361	385	410	435
April	3.52	347	374	402	429	457	484
May	3.40	335	361	388	415	441	468
June	2.11	208	224	241	257	274	290
July	2.52	249	268	288	307	327	347
August	2.25	222	239	257	274	292	310
September	2.36	233	251	269	288	306	325
October	2.65	261	282	302	323	344	365
November	2.05	202	218	234	250	266	282
December	1.50	148	159	171	183	195	206
Total	27.86	2,749	2,960	3,179	3,397	3,616	3,834

a. Acreage is from **Table F-32**.

Field Crops

Sugarcane is the most significant field crop within the LWC Planning Area. It is produced commercially in the Hendry and Glades areas. Other field crops grown within the LWC Planning Area include rice, seed corn, and soybean. Rice is produced commercially in the Glades Area and seed corn and soybean are produced commercially in the Charlotte Area.

Sugarcane

Historical sugarcane acreage data were gathered from annual volumes of the Field Crops Summary (FASS, various issues). Approximately 20 percent more land is associated with sugarcane production than will be reported as production by FASS. This is due to the manner in which sugar cane is propagated. Sugarcane is initially propagated vegetatively by planting stalk cuttings. The first harvest takes place approximately 13 months after planting. Roots are left in the ground (ratooned) and yield additional crops of sugarcane which take about 12 months to reach maturity. Sugar production per unit of land surface declines gradually and progressively with each additional ratoon, and there comes a point where the increased yields associated with replanting outweigh the cost of replanting. In Florida this point comes on average after four years (1 planting and 3 ratoons). The final ratoon on a parcel of land will be harvested from November through March and replanting will take place from September through January. During the months between harvesting and replanting, no sugarcane is on that parcel and the land is fallowed during this period. This land will not require irrigation and, therefore, is not included in the projections presented here.

Sugarcane acreage projections were developed using trend analysis. Sugar cane acreage growth is limited by available space or haulage distance to the nearest sugar mill.The historical projections, presented in the tables, are net acres based on FASS information. During the development of the CWMP additional sugarcane acres were added to these projections. Based on local knowledge provided by agricultural interests on the CWMP Advisory Committee, an additional 45,210 gross acres of sugarcane were added to these projections. These 45,210 gross acres were combined with the converted historical projection's net acreages resulting in a total of 125,007 gross acres of sugarcane in the Caloosahatchee basin for the 2020 demand projections for modeling purposes. A variety of variables and functional forms were tested and two models which were able to explain past trends in sugarcane acreage are shown in **Equations F-28** and **F-29**.

$$A_{jt} = a + (b_1 \text{ x } t) + (b_2 \text{ x } D) \qquad (F\text{-}28)$$

$$A_{jt} = a + (b_1 \text{ x } P_{re}) + (b_2 \text{ x } t) + (b_3 \text{ x } t \text{ x } D) \qquad (F\text{-}29)$$

where:

A_{jt} = *sugarcane acreage in area j in time t*

t = *a linear trend variable*

P_{re} = *the real price of sugarcane received by farmers*

D = *a dichotomous variable equal to zero prior to 1985 and equal to one from 1985 to the present*

Hendry Area Sugarcane

Historic sugarcane acreages for Hendry County are presented in **Table F-34**.

Table F-34. Historic Sugarcane Acreage in Hendry County[a].

Year	Historic	Year	Historic
1975	50,637	1987	61,720
1976	52,545	1988	62,525
1977	51,579	1989	60,252
1978	53,214	1990	76,467
1979	57,217	1991	78,533
1980	58,173	1992	77,500
1981	62,476	1993	75,433
1982	72,750	1994	75,433
1983	69,281	1995	72,333
1984	74,923	1996	72,333
1985	56,571	1997	73,366
1986	58,257		

a. An additional 45,210 gross acres of sugarcane were added for modeling purposes resulting in a total of 125,007 gross acres in the Caloosahatchee Basin. To prevent misrepresentation, gross acreages and net acreages are not combined in this table.

After examining a variety of functional forms, it was concluded that a flat projection for sugarcane and seed cane was appropriate. Consequently, Hendry County sugar and seed acreage was held flat at its 1997 level of 73,366 acres. The percentage of Hendry County sugarcane acreage within the LWC Planning Area is 49 percent, resulting in a constant primary projected sugarcane acreage of 36,927 acres for the Hendry Area through the year 2020. The primary range is from 31,388 to 42,466 acres.

There are two basic soil types, muck and sand, on which sugarcane is grown in Hendry County. Presently there are approximately 35,000 acres of sugarcane produced annually on muck in Hendry County and this is anticipated to remain constant over the projection period. All expansion in sugarcane acreage is expected to take place on sand. All modeling estimates are based on sandland sugarcane production. Sugarcane is assumed to use seepage irrigation, with an irrigation application efficiency of 50 percent. 1-in-2 and 1-in-10 irrigation requirements were calculated for the primary projection, and

are shown in **Table F-35.** For the calculation of irrigation requirements, data from the LaBelle rainfall station and soil with a water holding capacity of 0.8 in./ft. were used (**Table F-17**).

Table F-35. Irrigation Requirements for the Primary Sugarcane Acreage Projections in the Hendry Area.

Year		1995	2000 through 2020
Hendry County Acreage[a]		72,233	73,366
Hendry Area Acreage		35,443	36,927
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**	
1-in-2			
January	0.56	1,077	1,093
February	0.19	365	371
March	1.68	3,230	3,280
April	2.36	4,537	4,608
May	2.84	5,459	5,545
June	1.77	3,403	3,456
July	2.55	4,902	4,979
August	2.86	5,498	5,584
September	2.01	3,864	3,924
October	3.32	6,382	6,482
November	2.32	4,460	4,530
December	1.76	3,383	3,436
Total	24.25	46,616	47,348
1-in-10			
January	0.80	1,538	1,562
February	0.34	654	664
March	2.42	4,652	4,725
April	3.00	5,767	5,857
May	3.33	6,401	6,502
June	2.62	5,036	5,115
July	3.07	5,902	5,994
August	3.10	5,959	6,053
September	2.55	4,902	4,979
October	3.76	7,228	7,341
November	2.26	4,344	4,413
December	1.67	3,210	3,261
Total	28.92	55,594	56,466

a. Acreage is from **Table F-34**.

Glades Area Sugarcane

Historic Glades County sugarcane acreage is shown in **Table F-36**. The Glades County sugarcane acreage has been constant at 19,633 acres for the past eight years. This flat trend in acreage is projected to continue through 2020. Eighty-three percent of this sugarcane acreage, or 16,295 acres, is in the LWC Planning Area and the primary range is from 13,851 acres to 18,739 acres.

Table F-36. Historic Sugarcane Acreage in Glades County.[a]

Year	Historic	Year	Historic
1975	16,636	1987	20,020
1976	18,545	1988	20,321
1977	16,842	1989	20,119
1978	18,260	1990	19,633
1979	19,454	1991	19,633
1980	20,096	1992	19,633
1981	22,908	1993	19,633
1982	22,904	1994	19,633
1983	22,924	1995	19,633
1984	26,015	1996	19,633
1985	15,599	1997	19,633
1986	17,165		

a. An additional 45,210 gross acres of sugarcane were added for modeling purposes resulting in a total of 125,007 gross acres in the Caloosahatchee Basin. To prevent misrepresentation, gross acreages and net acreages are not combined in this table.

Average (1-in-2) and 1-in-10 irrigation requirements were calculated for the primary projection using **Equation F-15** (**Table F-37**). For the calculation of irrigation requirements, data from the Moore Haven rainfall station and soil with a water holding capacity of 0.8 in./ft. were used. Sugarcane is grown on both muck and sand in the Glades Area. Presently there are approximately 13,000 acres of sugarcane produced annually on muck. Sugarcane is assumed to use seepage irrigation, with an irrigation application efficiency of 50 percent. The input variables used are summarized in **Table F-17** at the beginning of the crop discussion.

Table F-37. Irrigation Requirements for the Primary Sugarcane Acreage Projections in the Glades Area through the Year 2020.

Year	1995 through 2020			
Glades County Acreage	19,633			
Glades Area Acreage	16,295			
	1-in-2		1-in-10	
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)
January	0.61	540	0.77	681
February	0.20	177	0.31	274
March	1.68	1,487	2.37	2,097
April	2.37	2,097	2.97	2,628
May	2.86	2,531	3.50	3,098
June	2.47	2,186	3.36	2,974
July	2.99	2,646	3.67	3,248
August	3.33	2,947	3.61	3,195
September	1.93	1,708	2.34	2,071
October	3.54	3,133	4.05	3,584
November	2.34	2,071	2.40	2,124
December	1.83	1,620	1.97	1,743
Total	26.14	23,134	31.31	27,710

Glades Area Rice

Rice is grown in Glades County during the summer months in rotation with sugarcane or winter vegetables, taking place on land that would otherwise be fallow. All of the rice grown within Glades County is within the Glades Area. Rice acreage in the Glades Area was assessed at 200 acres in 1995 by the local IFAS extension offices and research centers. Based on milling capacity, acreage is projected to increase to 800 acres by 2020.

The 1-in-2 and 1-in-10 supplemental water requirements for rice in the Glades Area are shown in **Table F-38.** The supplemental water requirements were divided by irrigation application efficiency to yield 1-in-2 and 1-in-10 irrigation requirements (**Equation F-15**). For the calculation of irrigation requirements, data from the Moore Haven rainfall station, soil with a water holding capacity of 0.8 in./ft., and the estimated application efficiency of seepage irrigation were used (**Table F-17**).

Table F-38. Irrigation Requirements for the Primary Rice Acreage Projections in the Glades Area.

Year		1995	2000 through 2020
Glades County Acreage		200	800
Glades Area Acreage		200	800
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**	
1-in-2			
January	1.33	14	58
February	2.72	30	118
March	3.66	40	159
April	0.00	0	0
May	0.00	0	0
June	0.00	0	0
July	0.00	0	0
August	0.00	0	0
September	0.00	0	0
October	1.97	21	86
November	3.62	39	157
December	2.80	30	122
Total	16.09	175	699
1-in-10			
January	1.50	16	65
February	2.85	31	124
March	4.43	48	192
April	0.00	0	0
May	0.00	0	0
June	0.00	0	0
July	0.00	0	0
August	0.00	0	0
September	0.00	0	0
October	2.43	26	106
November	3.69	40	160
December	2.94	32	128
Total	17.84	194	775

Charlotte Area Seed Corn and Soy Beans

Field crop production in the Charlotte Area varies from year to year, based primarily on the demand for seed corn, which, in turn, is dependent on seed corn production in other parts of the country. This variation in production is more of a fluctuation than a trend. For 1995, the local IFAS extension office estimated Charlotte County seed corn production at 2,100 acres and soybean production at 1,000 acres. This acreage is all located within the Charlotte Area. While fluctuations are anticipated, the magnitude of this acreage is typical and projected acreages for these crops were continued at their current level.

The 1-in-2 and 1-in-10 supplemental water requirements for rice in the Glades Area are shown in **Table F-39.** The supplemental water requirements were divided by irrigation application efficiency to yield 1-in-2 and 1-in-10 irrigation requirements (**Equation F-15**). For the calculation of irrigation requirements, data from the LaBelle rainfall station, soil with a water holding capacity of 0.8 in./ft., and the estimated application efficiency of seepage irrigation were used (**Table F-17**).

Table F-39. Irrigation Requirements for Seed Corn and Soy Bean Acreage in the Charlotte Area through the Year 2020.

Year	**1995 through 2020**			
Charlotte County Acreage	3,100			
Charlotte Area Acreage	3,100			
	1-in-2		**1-in-10**	
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**
January	0.37	62	0.59	99
February	1.86	313	2.02	340
March	3.16	532	3.98	670
April	0.00	0	0.00	0
May	0.00	0	0.00	0
June	0.00	0	0.00	0
July	0.00	0	0.00	0
August	0.00	0	0.00	0
September	0.00	0	0.00	0
October	0.35	59	0.71	120
November	2.53	426	2.48	418
December	2.31	389	2.22	374
Total	10.58	1,782	12.00	2,020

Tropical fruit

With the exception of citrus, all categories of tropical fruit (avocados, mangoes, etc.) were grouped together for projection purposes. Lee is the only county in the LWC Planning Area with significant tropical fruit acreage.

Lee County Tropical Fruit

In 1995, Lee County had 1,930 acres of tropical fruit (IFAS, 1989). A statistically valid trend could not be established due to insufficient historical data. However, the local IFAS extension office estimated that presently tropical fruit acreage is increasing at a rate of approximately 50 acres a year. This leads to estimates of tropical fruit acreage to be 2,180 acres in 2000, 2,430 acres in 2005, 2,680 acres in 2010, 2,930 acres in 2015, and 3,180 acres in 2020 (**Table F-40**).

The District's Blaney-Criddle permitting model has no category for tropical fruit as a grouping. The crop category of avocado was used to calculate irrigation requirements for all tropical fruit since they currently make up over 80 percent of the permitted noncitrus tropical fruit acreage in Lee County.

Ninety percent of the tropical fruit acreage currently permitted belongs to one large permittee which produces the bulk of avocados in Lee County. Although the current acreage is mostly seepage irrigated it is felt by the local IFAS extension office that future tropical fruit acreage will be irrigated with micro irrigation for reasons similar to those which justify its use on future citrus acreage.

The irrigation requirements for 1995 through 2020 were estimated assuming that the tropical fruit was irrigated with a 50 percent efficiency factor. Average (1-in-2) and 1-in-10 irrigation requirements for the primary tropical fruit acreage projections for Lee County are presented in **Table F-40.** Data from the Fort Myers rainfall station and soil with a water holding capacity of 0.8 in./ft. were used (**Table F-17**).

Table F-40. Irrigation Requirements for the Primary Tropical Fruit Acreage Projections in Lee County.

Year		1995	2000	2005	2010	2015	2020
Lee County Acreage		1,930	2,180	2,430	2,680	2,930	3,180
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	0.20	21	24	26	29	32	35
February	0.67	70	79	88	98	107	116
March	2.15	225	255	284	313	342	371
April	3.20	335	379	422	466	509	553
May	3.63	381	430	479	528	578	627
June	1.92	201	227	253	279	306	332
July	2.27	238	269	300	330	361	392
August	1.77	186	210	234	258	282	306
September	0.84	88	99	111	122	134	145
October	1.69	177	200	223	246	269	292
November	1.25	131	148	165	182	199	216
December	0.48	50	57	63	70	76	83
Total	20.06	2,103	2,375	2,647	2,920	3,192	3,465
1-in-10							
January	0.44	46	52	58	64	70	76
February	0.82	86	97	108	119	130	142
March	2.80	294	332	370	408	446	484
April	3.83	401	453	505	557	609	661
May	4.19	439	496	553	610	667	724
June	2.86	300	339	377	416	455	494
July	3.10	325	367	409	451	493	535
August	2.30	241	272	304	335	366	397
September	0.99	104	117	131	144	158	171
October	2.17	227	257	286	316	345	375
November	1.34	140	159	177	195	213	231
December	0.59	62	70	78	86	94	102
Total	25.44	2,667	3,012	3,358	3,703	4,048	4,394

Vegetables

A variety of vegetable crops are grown in the LWC Planning Area. These include cucumbers, peppers, squash, eggplant, tomatoes, potatoes, latin vegetables, and watermelon. They were grouped together for projection purposes. This was validated by the lack of significant difference in the irrigation requirements of different types of vegetables cultivated in the LWC Planning Area, and because different types of vegetables are often grown interchangeably.

Historic vegetable acreages were determined using data reported in the FASS Vegetable Summaries. In some instances, data on a specific crop within a specific county was not available. In these case either an estimate or default value was provided by the local IFAS extension office. Adjustments then had to be made to all of the data to account for double-cropping, nonharvested acreage, and the land between rows.

Historic acreages were assembled following the steps listed below for Collier, Lee, and Hendry counties. The data available for Glades and Charlotte counties was insufficient for this method to be used. The resulting historic acreages for Collier, Lee, and Hendry counties are presented in **Tables F-42**, **F-45**, and **F-48**.

1. Data was gathered from FASS Vegetable Summaries and/or from the local IFAS extension office.
2. Much of the vegetable land is double-cropped, and as many of the acreage data sources report harvested production, these data had to be adjusted to reflect acres of land in production. FASS and IFAS reports acreage as acres of production, i.e., 10 acres of land cultivated twice a year is reported as 20 acres. Acreages of double-cropped vegetables (cucumbers, peppers, squash, tomatoes, and eggplants) were divided by two to reflect the two growing seasons, and summed to yield the double-cropped subtotal.
3. The double-cropped and single-cropped vegetable acreages were subtotaled.
4. An examination of historical planted versus harvested acreage for vegetable crops within South Florida showed that an average of 15 percent of the acreage cultivated is not harvested. As FASS presently only reports harvested acreage, this 15 percent needed to be added to reflect the nonharvested vegetable row acreage. Therefore, the subtotal of all crops was increased by 15 percent to account for nonharvested acreage.
5. Vegetable acreage data reported in the in the FASS Vegetable Summaries and by IFAS represent the estimated area of land in the production rows, or, as it is sometimes termed, “under plastic”. The District's model for estimating irrigation requirements is based on total land acreage, which includes the

land necessary for vegetable production, but not in rows (spaces between rows, irrigation furrows, etc.). Land in rows represents approximately 60 percent of this total land (Pitts, 1991), so the row acreage was divided by 0.6 to yield the total acreage column.

Vegetable fields are usually planted and harvested sequentially, therefore, some portion of the land acreage used for vegetable production is commonly vacant. This temporal area of vegetable land vacancy effects total irrigation requirement, but it is difficult to quantify, because many eventualities occur which change production timing. For instance, freezes may necessitate replanting, which would delay the spring growing season; or growers may enter into a contract to harvest vegetables in any time window, which would in turn determine their growing season. Also, as seepage irrigation is the predominant type of irrigation system used for vegetable production, some of these vacant fields are unavoidably irrigated, either in part or whole. With these constraints in mind, generalized cultivation schedules were developed for each county with the assistance of the local IFAS extension office (**Table F-41).**

Vegetables are planted throughout the year, and crop evapotranspiration values depend on planting dates. In order to determine the supplemental irrigation requirements (**Equation F-16**) for vegetables, average evapotranspiration values were developed based on an average of Blaney-Criddle values with planting dates at the beginning of each month.

Vegetable acreage within the LWC Planning Area was particularily low during the 1996-97 growing season. This is due in part to unusually low vegetable prices. While more recent data from the 1997-98 Vegetable Summary indicates that the 1997-98 vegetable acreage increased over the 1996-97 levels, the downward trend is expected to continue. However, the ability of growers to move rapidly into and out of vegetable production makes long range forcasting difficult.

Table F-41. Generalized Cultivation Schedule for Vegetable Crops.

		Tomatoes	Cucumbers	Squash	Peppers	Potatoes	Watermelons	Total
Total Acres Produced		8,500	450	350	2,750	1,600	1,900	15,550
Total Acres of Land		4,250	225	175	1,375	1,600	1,900	9,525
Crops per year		2	2	2	2	1	1	
Percent in Ground								
January	Acres Produced	50%	50%	50%	50%	100%	50%	
	Acres of Land	22%	1%	1%	7%	17%	10%	58%
February	Acres Produced	100%	100%	100%	100%	100%	100%	
	Acres of Land	45%	2%	2%	14%	17%	20%	100%
March	Acres Produced	100%	100%	100%	100%	66%	100%	
	Acres of Land	45%	2%	2%	14%	11%	20%	94%
April	Acres Produced	100%	100%	100%	100%	33%	100%	
	Acres of Land	45%	2%	2%	14%	6%	20%	89%
May	Acres Produced	50%	50%	50%	50%	0%	50%	
	Acres of Land	22%	1%	1%	7%	0%	10%	42%
June	Acres Produced	0%	0%	0%	0%	0%	0%	
	Acres of Land	0%	0%	0%	0%	0%	0%	0%
July	Acres Produced	0%	0%	0%	0%	0%	0%	
	Acres of Land	0%	0%	0%	0%	0%	0%	0%
August	Acres Produced	50%	50%	50%	50%	0%	0%	
	Acres of Land	22%	1%	1%	7%	0%	0%	32%
September	Acres Produced	100%	100%	100%	100%	0%	0%	
	Acres of Land	45%	2%	2%	14%	0%	0%	63%
October	Acres Produced	100%	100%	100%	100%	100%	0%	
	Acres of Land	45%	2%	2%	14%	17%	0%	80%
November	Acres Produced	100%	100%	100%	100%	100%	0%	
	Acres of Land	45%	2%	2%	14%	17%	0%	80%
December	Acres Produced	50%	50%	50%	50%	100%	0%	
	Acres of Land	22%	1%	1%	7%	17%	0%	48%

Collier County Vegetables

Table F-42 shows historical vegetable acreage in Collier County. Acreage data for cucumbers, peppers, squash, tomatoes, and watermelons were gathered from FASS Vegetable Summaries. A default value for potatoes was estimated by the local IFAS vegetable extension agent.

Table F-42. Historic Collier County Vegetable Acreage.

	Step 1[a]				Step 2	Step 1		Step 3	Step 4	Step 5
	Double-Cropped					Single-Cropped				
Year	Cucumbers	Peppers	Squash	Tomatoes	Double-Cropped Subtotal	Watermelons	Potatoes	Subtotal of all Crops	Nonharvested Subtotal	Total
1967	3,250	3,180	760	2,060	4,625	2,900	1,600	9,125	10,494	17,490
1968	3,600	2,630	450	2,000	4,340	2,700	1,600	8,640	9,936	16,560
1969	4,070	3,530	340	1,940	4,940	3,000	1,600	9,540	10,971	18,285
1970	2,750	2,430	520	3,240	4,470	2,300	1,600	8,370	9,626	16,043
1971	2,900	2,950	420	2,885	4,578	2,900	1,600	9,078	10,439	17,399
1972	2,850	2,930	460	3,400	4,820	2,590	1,600	9,010	10,362	17,269
1973	2,700	3,650	460	3,520	5,165	1,600	1,600	8,365	9,620	16,033
1974	2,450	3,500	520	3,230	4,850	1,700	1,600	8,150	9,373	15,621
1975	3,400	3,890	1,000	3,775	6,033	1,450	1,600	9,083	10,445	17,408
1976	3,700	5,050	1,050	4,380	7,090	1,200	1,600	9,890	11,374	18,956
1977	3,070	5,850	1,900	5,110	7,965	1,400	1,600	10,965	12,610	21,016
1978	3,050	6,250	1,550	6,630	8,740	1,350	1,600	11,690	13,444	22,406
1979	2,600	4,750	1,500	6,800	7,825	1,850	1,600	11,275	12,966	21,610
1980	2,350	4,050	1,550	7,235	7,593	2,150	1,600	11,343	13,044	21,740
1981	2,450	4,000	1,700	9,130	8,640	2,400	1,600	12,640	14,536	24,227
1982	2,500	3,800	1,550	7,510	7,680	2,500	1,600	11,780	13,547	22,578
1983	2,100	3,400	1,800	7,950	7,625	2,700	1,600	11,925	13,714	22,856
1984	1,900	3,000	1,900	8,650	7,725	3,100	1,600	12,425	14,289	23,815
1985	1,600	2,800	2,000	8,800	7,600	3,500	1,600	12,700	14,605	24,342
1986	2,100	3,100	1,700	9,400	8,150	3,500	1,600	13,250	15,237	25,396
1987	1,700	3,800	1,500	12,000	9,500	3,400	1,600	14,500	16,675	27,792
1988	1,350	4,800	1,100	14,560	10,905	4,000	1,600	16,505	18,981	31,635
1989	1,350	5,100	1,000	16,250	11,850	4,600	1,600	18,050	20,758	34,596
1990	1,300	5,200	700	13,750	10,475	4,700	1,600	16,775	19,291	32,152
1991	1,000	5,400	550	13,660	10,305	3,300	1,600	15,205	17,486	29,143
1992	1,750	4,500	600	14,100	10,475	4,000	1,600	16,075	18,486	30,810
1993	1,330	5,525	500	12,900	10,128	3,000	1,600	14,728	16,937	28,228
1994	800	6,000	1,100	12,700	10,300	4,000	1,600	15,900	18,285	30,475
1995	725	4,075	1,250	10,325	8,188	2,800	1,600	12,588	14,476	24,126
1996	700	3,060	650	10,400	7,405	2,500	1,600	11,505	13,231	22,051
1997	450	2,750	350	8,500	6,025	1,900	1,600	9,525	10,954	18,256

a. Steps from **page F-63**.

ARIMA (auto regressive integrated moving average) modeling was used to forecast future vegetable acreage in Collier County. For a discussion of ARIMA modeling, see Box, Jenkins, and Reinsel (1994) and Hintze (1999). ARIMA modeling takes a series of data points, such as Collier County vegetable acreage, and by examining auto correlations in the data, develops a description of a stochastic process which describes the observed data and can be used to forecast future values in the series. The model developed to forecast Collier County vegetable acreage, shown in **Equation F-30** below, represents a (2,1,0) (two auto regressive terms, first differencing, no moving average terms) logarithmic model. The resulting projected acreages for Collier County vegetables is shown in **Table F-43**.

(F-30)

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Variable LOG10(TOTVEG)-MEAN

Model Description Section

Series	LOG10(TOTVEG)-MEAN
Model	Regular(2,1,0) Seasonal(No seasonal parameters)
Mean	4.348372
Observations	31
Iterations	1
Pseudo R-Squared	85.853993
Residual Sum of Squares	4.430294E-02
Mean Square Error	1.582248E-03
Root Mean Square	3.977748E-02

Model Estimation Section

Parameter Name	Parameter Estimate	Standard Error	T-Value	Prob Level
AR(1)	8.303617E-02	0.1914817	0.4337	0.664542
AR(2)	0.3054164	0.1907544	1.6011	0.109355

Asymptotic Correlation Matrix of Parameters

	AR(1)	AR(2)
AR(1)	1.000000	0.024034
AR(2)	0.024034	1.000000

Table F-43. Projected Vegetable Acreage the Collier County.

Year	Primary - 15%	Primary	Primary + 15%
1995	20,507	24,126[a]	27,745
1997	15,518	18,256[a]	20,994
2000	13,057	15,361	17,666
2005	12,174	14,322	16,471
2010	11,921	14,025	16,128
2015	11,646	13,701	15,756
2020	11,549	13,587	15,625

a. From **Table F-43**

Table F-44 shows the supplemental water requirements and the irrigation requirements for vegetables in Collier County during 1-in-2 years and 1-in-10 drought years. Data from the Immokalee rainfall station and soil with a water holding capacity of 0.8 in./ft. were used in the calculations (**Table F-17**).

Table F-44. Irrigation Requirements for the Primary Vegetable Acreage Projections in Collier County.

Year		1995	2000	2005	2010	2015	2020
Collier County Acreage[a]		24,126	15,361	14,322	14,025	13,701	13,587
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	0.99	1,297	826	770	754	737	731
February	1.96	2,568	1,635	1,525	1,493	1,458	1,446
March	2.12	2,778	1,769	1,649	1,615	1,578	1,564
April	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0
October	1.84	2,411	1,535	1,431	1,402	1,369	1,358
November	2.58	3,381	2,152	2,007	1,965	1,920	1,904
December	1.59	2,083	1,327	1,237	1,211	1,183	1,173
Total	11.08	14,518	9,244	8,619	8,440	8,245	8,176
1-in-10							
January	1.12	1,468	934	871	853	833	826
February	2.28	2,988	1,902	1,774	1,737	1,697	1,682
March	2.86	3,748	2,386	2,225	2,179	2,128	2,111
April	0.00	0	0	0	0	0	0
May	0.00	0	0	0	0	0	0
June	0.00	0	0	0	0	0	0
July	0.00	0	0	0	0	0	0
August	0.00	0	0	0	0	0	0
September	0.00	0	0	0	0	0	0
October	2.42	3,171	2,019	1,882	1,843	1,801	1,786
November	2.75	3,603	2,294	2,139	2,095	2,046	2,029
December	1.74	2,280	1,452	1,353	1,325	1,295	1,284
Total	13.16	17,244	10,979	10,237	10,024	9,793	9,711

a. Acreages are from **Table F-46**.

Lee County Vegetables

Table F-45 shows the historical vegetable acreage in Lee County by type. Historical acreage data for cucumbers, peppers, tomatoes, and watermelons were gathered from FASS Vegetable Summaries. Historical squash and potato acreage was assessed as a constant percentage of production in the "South" region of Florida (as reported by FASS), based on production data provided by the local IFAS extension office for the 1988-1989 growing season (IFAS, 1991). A default value of 1,000 acres of latin vegetables was based on production reported by the local IFAS extension office for the 1988-89 growing season (IFAS, 1989). A default value of 500 acres was entered for watermelon for the six year period between 1977 and 1982. During this period FASS incorporated Lee County's watermelon acreage with several other counties and reported a total for the "South" region.

Table F-45. Historic Vegetable Acreage in Lee County.

	Step 1[a]				Step 2	Step 1			Step 3	Step 4	Step 5
	Double-Cropped					Single-Cropped					
Year	Cucumbers	Peppers	Squash	Tomatoes	Double-Cropped Subtotal	Potatoes	Latin	Watermelon	Subtotal of all Crops	Nonharvested Subtotal	Total
1974	1,580	1,650	674	600	2,252	278	1,000	600	4,130	4,750	7,917
1975	1,500	1,830	907	640	2,438	251	1,000	450	4,140	4,761	7,935
1976	1,550	1,850	953	485	2,419	215	1,000	450	4,085	4,697	7,829
1977	1,380	1,950	1,209	650	2,595	215	1,000	500	4,310	4,957	8,261
1978	1,500	2,230	1,079	1,145	2,977	215	1,000	500	4,692	5,396	8,994
1979	1,500	2,280	1,130	1,595	3,253	233	1,000	500	4,986	5,734	9,556
1980	1,350	1,950	1,163	1,790	3,126	215	1,000	500	4,842	5,568	9,280
1981	1,400	1,800	1,209	1,040	2,725	260	1,000	500	4,485	5,158	8,596
1982	1,450	1,900	1,395	1,210	2,978	278	1,000	500	4,756	5,469	9,115
1983	1,450	1,750	1,442	920	2,781	188	1,000	500	4,469	5,140	8,566
1984	1,600	1,650	1,488	650	2,694	269	1,000	600	4,563	5,248	8,747
1985	2,000	1,600	1,581	1,030	3,106	305	1,000	1,000	5,411	6,222	10,371
1986	2,000	1,350	1,279	1,670	3,150	287	1,000	800	5,237	6,022	10,037
1987	1,800	1,500	1,093	1,700	3,047	287	1,000	700	5,034	5,789	9,648
1988	1,650	1,700	977	1,480	2,903	287	1,000	800	4,991	5,739	9,565
1989	1,450	1,800	900	1,540	2,845	359	1,000	1,100	5,304	6,100	10,166
1990	1,650	1,600	900	1,350	2,750	455	1,000	900	5,105	5,871	9,785
1991	1,700	1,650	750	2,310	3,205	455	1,000	900	5,560	6,394	10,657
1992	1,500	1,600	1,000	2,200	3,150	455	1,000	900	5,505	6,331	10,551
1993	1,450	1,350	1,100	2,800	3,350	455	1,000	1,600	6,405	7,366	12,276
1994	0	800	2,200	3,000	3,000	455	1,000	1,400	5,855	6,733	11,222
1995	0	1,265	1,600	2,725	2,795	455	1,000	1,000	5,250	6,038	10,063
1996	0	0	1,150	2,475	1,813	455	1,000	1,100	4,368	5,023	8,371
1997	0	0	450	2,000	1,225	455	1,000	1,000	3,680	4,232	7,053

a. Steps from **page F-63**.

Since acreage estimates for all vegetable crops were aggregated for projection purposes, there is no single price measure which accurately reflects the economic returns to vegetable production. Consequently, double exponential smoothing was used to project Lee County vegetable acreage. The basic equations for double exponential smoothing are shown in **Equations F-31** through **F-34**. For a more detailed discussion of double exponential smoothing see Hintze (1999) and Thomopoulos (1983).

$F_t = a_t + b_t$ *(F-31)*

$at = Xt + (1-I)2et$ *(F-32)*

$bt = bt-1 + I2\ et$ *(F-33)*

$et = Ft - Xt$ *(F-34)*

When the double exponential smoothing model shown in **Equations F-31** through **F-34** was used to forecast Lee County vegetable acreage, the results shown in **Equation F-35** were obtained. Projected acreages are presented in **Table F-46**.

Forecast Summary Section *(F-35)*

Log10(Variable)Historic

Number of Rows26

Mean 9245.923

Pseudo R-Squared0.341084

Mean Square Error953378.9

Mean |Error|676.0744

Mean |Percent Error|7.447038

Forecast MethodDouble Smooth

Search CriterionNone

Alpha 0.3

Intercept (A)4.374196

Slope (B) -1.786233E-02

Warning Missing values were detected and replaced.

Table F-46. Projected Vegetable Acreage Lee County.

Year	Primary - 15%	Primary	Primary + 15%
1994-95	8,553	10,062[a]	11,571
1996-97	5,995	7,053[a]	8,111
1997-98	4,622	5,438	6,253
1999-00	4,099	4,822	5,545
2004-05	2,964	3,487	4,010
2009-10	2,040	2,401	2,761
2014-15	1,288	1,516	1,743
2019-20	676	796	915

a. From **Table F-45**.

Lee County vegetable irrigation requirements were estimated based on two three-month growing seasons: September through December and January through March. For the calculation of irrigation requirements, data from the Fort Myers rainfall station and soil with a water holding capacity of 0.8 in./ft. were used. Vegetables are assumed to use seepage irrigation systems with an irrigation application efficiency of 50 percent. Average (1-in-2) and 1-in-10 irrigation requirements for the primary vegetable acreage projection for Lee County are presented in **Table F-47**.

Table F-47. Irrigation Requirements for the Primary Vegetable Acreage Projections in Lee County.

Year		1995	2000	2005	2010	2015	2020
Lee County Acreage[a]		10,062	4,822	3,487	2,401	1,516	796
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.17	639	306	222	153	96	51
February	2.06	1,126	539	390	269	170	89
March	2.34	1,279	613	443	305	193	101
April	0.00	0	0	0	0	0	0
May	0.00	0	0	0	0	0	0
June	0.00	0	0	0	0	0	0
July	0.00	0	0	0	0	0	0
August	0.00	0	0	0	0	0	0
September	0.00	0	0	0	0	0	0
October	1.67	913	437	316	218	138	72
November	2.89	1,579	757	547	377	238	125
December	1.68	918	440	318	219	138	73
Total	11.82	6,459	3,096	2,239	1,541	973	511
1-in-10							
January	1.43	781	375	271	186	118	62
February	2.23	1,219	584	422	291	184	96
March	3.00	1,639	786	568	391	247	130
April	0.00	0	0	0	0	0	0
May	0.00	0	0	0	0	0	0
June	0.00	0	0	0	0	0	0
July	0.00	0	0	0	0	0	0
August	0.00	0	0	0	0	0	0
September	0.00	0	0	0	0	0	0
October	2.14	1,169	560	405	279	176	93
November	2.99	1,634	783	566	390	246	129
December	1.81	989	474	343	236	149	78
Total	13.60	7,432	3,562	2,576	1,773	1,120	588

a. Acreages are from **Table F-46**.

Hendry County Vegetables

Table F-48 shows historical acreages used for Hendry County vegetable production. Acreage data for cucumbers, peppers, tomatoes, and watermelons were gathered from FASS Vegetable Summaries. A default value for squash and eggplant was estimated by the local IFAS extension office.

Table F-48. Historic Vegetable Acreage in Hendry County.

	Step 1[a]				Step 2	Step 1	Step 3	Step 4	Step 5
	Double-Cropped					Single-Cropped			
Year	Cucumbers	Peppers	Tomatoes	Squash and Eggplant	Double-Cropped Subtotal	Watermelons	Subtotal of all Crops	Non-harvested Subtotal	Total
1966-67	950	800	5,810	600	4,080	3,800	7,880	9,062	15,103
1967-68	1,225	950	5,680	600	4,228	4,200	8,428	9,692	16,153
1968-69	1,290	1,200	4,720	600	3,905	3,500	7,405	8,516	14,193
1969-70	1,200	1,920	4,975	600	4,348	3,100	7,448	8,565	14,274
1970-71	1,240	1,930	4,420	600	4,095	3,600	7,695	8,849	14,749
1971-72	1,060	1,780	3,710	600	3,575	3,880	7,455	8,573	14,289
1972-73	900	1,580	4,110	600	3,595	2,450	6,045	6,952	11,586
1973-74	900	1,500	2,720	600	2,860	2,200	5,060	5,819	9,698
1974-75	1,500	1,670	2,255	600	3,013	2,050	5,063	5,822	9,703
1975-76	1,700	2,100	2,305	600	3,353	1,650	5,003	5,753	9,588
1976-77	1,850	2,200	1,030	600	2,840	1,900	4,740	5,451	9,085
1977-78	1,750	2,250	2,095	600	3,348	1,550	4,898	5,632	9,387
1978-79	1,750	2,200	2,580	600	3,565	1,500	5,065	5,825	9,708
1979-80	1,600	1,850	2,775	600	3,413	1,950	5,363	6,167	10,278
1980-81	1,650	1,760	2,530	600	3,270	2,500	5,770	6,635	11,059
1981-82	1,700	1,700	2,080	600	3,040	2,600	5,640	6,486	10,810
1982-83	1,600	1,600	1,530	600	2,665	3,100	5,765	6,630	11,050
1983-84	1,500	1,300	1,085	600	2,243	3,000	5,243	6,029	10,048
1984-85	1,200	1,200	1,370	600	2,185	2,800	4,985	5,733	9,555
1985-86	1,600	1,300	1,580	600	2,540	2,600	5,140	5,911	9,852
1986-87	1,800	1,700	1,700	600	2,900	2,500	5,400	6,210	10,350
1987-88	1,450	1,800	2,360	600	3,105	2,500	5,605	6,446	10,743
1988-89	1,600	3,000	3,270	600	4,235	2,500	6,735	7,745	12,909
1989-90	1,650	2,500	2,550	600	3,650	2,200	5,850	6,727	11,212
1990-91	1,150	1,900	3,830	600	3,740	1,900	5,640	6,486	10,810
1991-92	1,400	2,150	4,700	600	4,425	2,300	6,725	7,734	12,890
1992-93	1,150	2,000	3,950	600	3,850	2,500	6,350	7,303	12,171
1993-94	900	2,800	5,050	600	4,675	2,900	7,575	8,711	14,519
1994-95	1,600	2,760	5,200	600	5,080	2,500	7,580	8,717	14,528
1995-96	1,350	4,405	4,125	600	5,240	3,200	8,440	9,706	16,177
1996-97	1,300	3,100	3,300	600	4,150	2,600	6,750	7,763	12,938

a. Steps from **page F-63**.

Since acreage estimates for all vegetable crops were aggregated for projection purposes, there is no single price measure that accurately reflects the economic returns to vegetable production. Consequently an ARIMA model was used to forecast the Hendry County vegetable acreage. This is the same general approach as was used to project Collier County vegetable acreage. A model using log-transformed data with a trend and one auto regressive, no differencing, and one moving average term was estimated as shown in **Equation F-36** below.

(F-36)

ARIMA Report

Page/Date/Time 1 04-16-1999 14:46:31
Database
Variable LOG10(Historic)-TREND

Model Description Section

Series	LOG10(Historic)-TREND
Model	Regular(1,0,1) Seasonal(No seasonal parameters)
Trend Equation	(4.071891)+(-1.696033E-04)x(date)
Observations	31
Iterations	2
Pseudo R-Squared	69.379696
Residual Sum of Squares	5.657366E-02
Mean Square Error	1.950816E-03
Root Mean Square	4.416804E-02

Model Estimation Section

Parameter Name	Parameter Estimate	Standard Error	T-Value	Prob Level
AR(1)	0.767853	0.2210278	3.4740	0.000513
MA(1)	-0.1477162	0.3364121	-0.4391	0.660594

Asymptotic Correlation Matrix of Parameters

	AR(1)	MA(1)
AR(1)	1.000000	0.850659
MA(1)	0.850659	1.000000

Projections for both Hendry County and the Hendry Area are presented in **Table F-49.** Fifty percent of Hendry County's vegetable acreage is within the LWC Planning Area. Projected vegetable acreage for the Hendry Area were determined by multiplying the projected vegetable acreage for the county by this percentage.

Table F-49. Projected Vegetable Acreage in Hendry County and the Hendry Area.

Year	Hendry County			Hendry Area		
	Primary - 15%	Primary	Primary + 15%	Primary - 15%	Primary	Primary + 15%
1995	12,349	14,528[a]	16,707	6,174	7,264	8,354
1999	8,288	9,751	11,214	4,876	5,607	2,438
2000	8,184	9,628	11,072	4,814	5,536	2,407
2005	7,925	9,324	10,723	4,662	5,361	2,331
2010	7,843	9,227	10,611	4,614	5,306	2,307
2015	7,807	9,185	10,563	4,593	5,281	2,296
2020	7,783	9,157	10,531	4,579	5,265	2,289

a. From **Table F-48**.

Table F-50 shows the supplemental water requirements and the irrigation requirements for vegetables in the Hendry Area during 1-in-2 years and 1-in-10 drought years. Data from the LaBelle rainfall station and soil with a water holding capacity of 0.8 in./ft. were used in the calculations (**Table F-17**).

Table F-50. Irrigation Requirements for the Primary Vegetable Acreage Projections in the Hendry Area.

Year		1995	2000	2005	2010	2015	2020
Hendry County Acreage[a]		14,528	9,628	9,324	9,227	9,185	9,157
Hendry Area Acreage[a]		7,264	5,536	5,361	5,306	5,281	5,265
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**					
1-in-2							
January	1.10	1,250	828	802	794	790	788
February	2.00	2,272	1,506	1,458	1,443	1,437	1,432
March	2.10	2,386	1,581	1,531	1,515	1,509	1,504
April	0.00	0	0	0	0	0	0
May	0.00	0	0	0	0	0	0
June	0.00	0	0	0	0	0	0
July	0.00	0	0	0	0	0	0
August	0.00	0	0	0	0	0	0
September	0.00	0	0	0	0	0	0
October	1.46	1,659	1,099	1,065	1,054	1,049	1,046
November	2.69	3,056	2,026	1,962	1,941	1,932	1,926
December	1.50	1,704	1,129	1,094	1,082	1,078	1,074
Total	10.85	12,328	8,170	7,912	7,830	7,794	7,770
1-in-10							
January	1.33	1,511	1,001	970	960	955	952
February	2.16	2,454	1,626	1,575	1,559	1,552	1,547
March	2.87	3,261	2,161	2,093	2,071	2,062	2,055
April	0	0	0	0	0	0	0
May	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0
July	0	0	0	0	0	0	0
August	0	0	0	0	0	0	0
September	0	0	0	0	0	0	0
October	1.85	2,102	1,393	1,349	1,335	1,329	1,325
November	2.64	3,000	1,988	1,925	1,905	1,896	1,891
December	1.42	1,613	1,069	1,035	1,025	1,020	1,017
Total	12.27	13,941	9,239	8,948	8,854	8,814	8,787

a. Acreages are from **Table F-49**.

Glades Area Vegetables

The Glades Area vegetable production is included in the "West Central" area as defined by the FASS Vegetable Summaries, and acreage data for the Glades Area individually is not available from FASS. The only vegetable acreage data available was that supplied by the local IFAS extension agent, and only for 1989. Due to the lack of historical data future vegetable acreage was projected at its current level. Present vegetable production is very modest in the Glades Area (approximately 473 acres), and is projected to remain constant by the local extension office. The primary projection for the six time horizons is therefore 473 acres, and the primary range is from 317 to 545 acres.

Vegetable crops grown in the Glades Area are usually cultivated twice a year between August and May with 100% of the cultivated crops in ground during all six months. Irrigation requirements were calculated using data collected from the Moore Haven rainfall station and soil with a water holding capacity of 0.8 in./ft. **Table F-51** presents estimated vegetable irrigation requirements in the Glades Area based on the projected constant vegetable acreage of 473 acres.

Table F-51. Irrigation Requirements for the Primary Vegetable Acreage Projections in the Glades Area through the Year 2020.

Year	**1995 through 2020**			
Glades County Acreage	763			
Glades Area Acreage	473			
	1-in-2		**1-in-10**	
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**
January	1.12	29	1.33	33
February	1.97	51	2.16	54
March	2.10	54	2.87	72
April	0	0	0.00	0
May	0	0	0.00	0
June	0	0	0.00	0
July	0	0	0.00	0
August	0	0	0.00	0
September	0	0	0.00	0
October	1.64	42	1.85	54
November	2.72	70	2.64	71
December	1.57	40	1.42	44
Total	11.13	286	12.26	328

Charlotte Area Vegetables

Charlotte County's historical vegetable acreage is combined with other counties' data when published in the FASS Vegetable Summaries. Because of this consolidation, data from the Vegetable Summaries were not suitable to establish crop acreages or production trends. Vegetable acreage in Charlotte County is estimated at 2,402 land acres, based on communication with the local Cooperative Extension Service representative.

No meaningful trend or explanatory mathematical model could be developed due to the lack of historical vegetable acreage data for Charlotte County. Therefore, irrigated vegetable acreage was projected to remain constant at 2,402 acres (with a primary range of 2,042 to 2,762 acres) through the year 2020. The projection of a constant vegetable acreage for Charlotte County is not inconsistent with the vegetable acreage projections developed for neighboring Hendry and Lee counties, where there were enough data to establish trends.

Unpublished SCS maps for 1989 show that about 96 percent of the vegetable production in Charlotte County takes place in the LWC Planning Area portion of the county. The vegetable land acreage estimate for the Charlotte Area was based on this ratio, and is equal to 2,306 acres with a primary range of 1,960 to 2,652.

The generalized vegetable cultivation schedule in the Charlotte Area is October through March with 100% of the 2,306 acres planted**. Table F-52** shows the supplemental water requirements and irrigation requirements for vegetable crops using the primary acreage projection and the cultivation schedule. For the calculation of irrigation requirements, data from the LaBelle rainfall station and soil with a water holding capacity of 0.8 in./ft. were used (**Table F-17**).

Table F-52. Irrigation Requirements for the Primary Vegetable Acreage Projections in the Charlotte Area through the Year 2020.

Year	1995 through 2020			
Charlotte County Acreage	**2,402**			
Charlotte Area Acreage	**2,306**			
	1-in-2		**1-in-10**	
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**
January	1.10	138	1.33	167
February	2.00	250	2.16	271
March	2.10	263	2.87	359
April	0.00	0	0.00	0
May	0.00	0	0.00	0
June	0.00	0	0.00	0
July	0.00	0	0.00	0
August	0.00	0	0.00	0
September	0.00	0	0.00	0
October	1.46	183	1.85	232
November	2.69	337	2.64	331
December	1.50	188	1.42	178
Total	10.86	1,360	12.26	1,535

Sod

There is some variation in the production practices of sod in the LWC Planning Area. Some harvested sod is irrigated, and some is not, serving largely as pasture until the sod is sold. As the objective here is to project irrigation requirement, only irrigated sod is addressed. Historical acreages of sod were provided by the local IFAS extension offices and research centers.

Lee County Sod

There were 650 acres of irrigated sod in Lee County in 1989 (IFAS, 1989). No meaningful trend or explanatory mathematical model could be developed due to the lack of historical sod acreage data in Lee County; and no convincing empirical knowledge of future changes in sod acreage was available from the local IFAS extension office. Therefore, irrigated sod acreage was projected to remain relatively constant through the year 2020 at 650 acres, and the primary range is from 553 to 748 acres.

The irrigation requirements in **Table F-53** were calculated by applying the current irrigated acreage to the District's modified Blaney-Criddle permitting model. Input variables used were 650 acres of grass, sandy soil with 0.8 in./ft. water holding capacity, seepage systems with an irrigation application efficiency of 50 percent, and data from the Fort Myers rainfall station (**Table F-17**).

Table F-53. Irrigation Requirements for the Primary Sod Acreage Projections in Lee County through the Year 2020.

Year	1995 through 2020			
Lee County Acreage	650			
	1-in-2		1-in-10	
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)
January	1.00	35	1.26	44
February	1.29	46	1.37	48
March	2.87	101	3.55	125
April	4.04	143	4.71	166
May	4.41	156	5.00	177
June	2.57	91	3.56	126
July	3.24	114	4.13	146
August	3.04	107	3.62	128
September	2.22	78	2.38	84
October	3.09	109	3.60	127
November	2.51	89	2.61	92
December	1.76	62	1.88	66
Total	31.95	1,128	37.68	1,330

Cut Flowers

Cut flower acreages are not included with the ornamental nursery acreage reported by the Division of Plant Industry, and are projected separately. Hendry is the only county in the LWC Planning Area with a significant cut flower acreage.

Hendry Area Cut Flowers

Currently there is only one company producing cut flowers (gladiolus) commercially in the Hendry Area. The local IFAS extension office estimated that approximately 1,000 acres of land is used at any one time for this purpose. No meaningful trend or explanatory mathematical model could be developed due to the lack of historical flower acreage data in the Hendry Area. Therefore, irrigated cut flower acreage was projected to remain constant through the year 2020. The primary projection through the year 2020 is 1,000 acres, and the primary range is from 850 to 1,150 acres.

Table F-54 shows the supplemental water requirements and irrigation requirements for Hendry Area cut flowers. For the calculation of irrigation requirements,

Table F-54. Irrigation Requirements for the Primary Cut Flower Acreage Projections in the Hendry Area through the Year 2020.

Year	1995 through 2020			
Hendry Area Acreage	1,000			
	1-in-2		1-in-10	
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)
January	0.93	51	1.16	63
February	1.15	62	1.30	71
March	2.62	142	3.41	185
April	3.68	200	4.38	238
May	4.12	224	4.65	253
June	2.54	0	3.44	0
July	3.39	0	3.94	0
August	3.30	0	3.55	0
September	2.84	154	3.40	185
October	2.84	154	3.26	177
November	2.32	126	2.26	123[a]
December	1.58	86	1.50	81[a]
Total	31.32	1,199	36.25	1,375

a. Indicates 1-in-10 irrigation requirements are less than 1-in-2 irrigation requirements.

data from the LaBelle rainfall station, soil with a water holding capacity of 0.8 in./ft. were used, and seepage irrigation systems with an irrigation application efficiency of 50 percent (**Table F-17**). Currently the Blaney-Criddle permitting model has no category of cut flowers so the value for sod is used for permitting purposes. Cut flowers grown in the Hendry Area are usually cultivated from September through May, with no production taking place in the months of June, July, and August. The absence of this crop in the summer months is reflected in the irrigation requirement calculation.

Ornamental Nursery

Historical commercial nursery acreage data were gathered from annual volumes of the Division of Plant Industry's Annual Reports (FDACS, Various Issues).

The majority of ornamental nurseries in the LWC Planning Area use overhead sprinkler systems for irrigation. Normally, overhead sprinkler irrigation systems are estimated by the District to have an irrigation application efficiency of 75 percent. However, an indeterminable number of nurseries containerize their plants, and this reduces the irrigation application efficiency to approximately 20 percent. To account for this range of efficiencies an overall efficiency of 50 percent was assumed.

Currently the District's Blaney-Criddle permitting model has no category for ornamental nursery, and the value for grass is used for permitting purposes.

Collier County Ornamental Nurseries

Collier County ornamental nursery acreage is expanding. However, due to the inconsistent nature of historical acreage data, no meaningful trend or explanatory mathematical model could be developed. In 1995, there were 1,288 acres of ornamental nursery in Collier County. In 1996, there were 1,246 acres. A reasonable projected growth rate for the next five years is 30 acres per year. If this rate is applied throughout the projection period, it leads to estimates of 1,365 acres in 2000, 1,515 acres in 2005, 1,665 acres in 2010, 1,815 acres in 2015, and 1,965 acres in 2020. Historical and projected Collier County ornamental nursery acreages are shown in **Tables F-55** and **F-56**, respectively**.**

Irrigation requirements for the ornamental nursery acreage projections are shown in **Table F-57**. For the calculation of irrigation requirements, data from the Naples rainfall station and soil with a water holding capacity of 0.8 in./ft. were used (**Table F-17**).

Table F-55. Historic Ornamental Nursery Acreage in Collier County.

Year	Historic	Year	Historic
1972	416	1985	227
1973	600	1986	226
1974	336	1987	528
1975	1035	1988	578
1976	360	1989	946
1977	496	1990	1,382
1979	329	1991	1,507
1980	286	1992	1,400
1981	291	1993	1,605
1982	328	1994	1,267
1983	328	1995	1,288
1984	260	1996	1,245

Table F-56. Projected Ornamental Nursery Acreage in Collier County.

Year	Primary - 15%	Primary	Primary + 15%
1995	1,095	1,288[a]	1,481
2000	1,160	1,365	1,570
2005	1,288	1,515	1,742
2010	1,415	1,665	1,915
2015	1,543	1,815	2,087
2020	1,670	1,965	2,260

a. From **Table F-55**.

Table F-57. Irrigation Requirements for the Primary Ornamental Nursery Acreage Projections in Collier County.

Year		1995	2000	2005	2010	2015	2020
Collier County Acreage[a]		1,288	1,365	1,515	1,665	1,815	1,965
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.09	76	81	90	99	107	116
February	1.35	94	100	111	122	133	144
March	3.30	231	245	272	298	325	352
April	4.07	285	302	335	368	401	434
May	4.24	297	314	349	383	418	453
June	3.16	221	234	260	286	312	337
July	3.44	241	255	283	311	339	367
August	3.31	232	245	272	299	326	353
September	2.22	155	165	183	201	219	237
October	2.91	204	216	239	263	287	311
November	2.66	186	197	219	241	262	284
December	1.97	138	146	162	178	194	210
Total	33.73	2,360	2,501	2,775	3,050	3,325	3,600
1-in-10							
January	1.27	89	94	104	115	125	136
February	1.49	104	110	123	135	147	159
March	3.86	270	286	318	349	381	412
April	4.82	337	357	397	436	475	514
May	4.97	348	368	409	449	490	530
June	4.34	304	322	357	392	428	463
July	4.19	293	311	345	379	413	447
August	3.74	262	277	308	338	369	399
September	2.72	190	202	224	246	268	290
October	3.15	220	234	259	285	311	336
November	2.85	199	211	235	258	281	304
December	2.15	150	159	177	194	212	229
Total	39.53	2,765	2,931	3,253	3,575	3,897	4,219

a. Acreages are from **Table F-56**.

Lee County Ornamental Nurseries

In order to project Lee County ornamental nursery acreage, a model of the form shown in **Equation F-37** was estimated.

$LEENON_t$ = *f(Time, D, logtime)* *(F-37)*

where:

$LEENON_t$ = *Lee County ornamental nursery acreage in year t.*

Time = *A time trend variable equal to one in 1972 and is increased by one unit per year thereafter.*

D = *one in 1993 and after, zero otherwise.*

Logtime = *The natural logarithm of time.*

The D variable was included to take into account a large increase from 739 acres to 939 acres in 1993 (**Table F-58**). It is hypothesized that this one-time increase in ornamental nursery acreage may have been associated with replacement of plants damaged by the freezes in the mid- to late-1980's.

Table F-58. Historic Ornamental Nursery Acreage in Lee County.

Year	Historic	Year	Historic
1972	251	1985	441
1973	264	1986	398
1974	158	1987	625
1975	285	1988	486
1976	232	1989	508
1977	267	1990	606
1978		1991	717
1979	251	1992	739
1980	370	1993	939
1981	406	1994	1,090
1982	437	1995	1,303
1983	413	1996	1,553
1984	430		

When **Equation F-37** was estimated using ordinary least squares, the results in **Equation F-38** were obtained. **Equation F-38** was estimated using ordinary least squares, with variables defined as:

Historic = *historic Lee County ornamental nursery acreage*

D_2 = *a dichotomous variable equal to one in 1993 and after and zero prior to 1993*

Time = *a time-trend variable equal to one in 1972 and increasing one unit per year thereafter*

Logtime = *the natural logarithm of Time*

Equation F-38 was used to generate the primary projection for Lee County ornamental nursery acreage. The resulting projections are shown in **Table F-59.**

(F-38)

Multiple Regression Report

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Dependent historic

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	244.8879	76.77889	3.1895	0.004605	Reject Ho	0.858403
D2	421.283	82.87559	5.0833	0.000057	Reject Ho	0.997928
Time	42.7734	10.18032	4.2016	0.000439	Reject Ho	0.978947
logtime	-142.6481	76.77893	-1.8579	0.077967	Accept Ho	0.424235
R-Squared	0.928344					

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	244.8879	76.77889	84.7299	405.0458	0.0000
D2	421.283	82.87559	248.4075	594.1584	0.4522
Time	42.7734	10.18032	21.53762	64.00919	0.8934
logtime	-142.6481	76.77893	-302.8061	17.50996	-0.3412
T-Critical	2.085963				

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	7224689	7224689			
Model	3	2686282	895427.1	86.3699	0.000000	1.000000
Error	20	207347	10367.35			
Total(Adjusted)	23	2893629	125809.9			

Root Mean Square Error	101.8202	R-Squared	0.9283
Mean of Dependent	548.6608	Adj R-Squared	0.9176
Coefficient of Variation	0.1855795	Press Value	353568.1
Sum |Press Residuals|	2064.954	Press R-Squared	0.8778

Normality Tests Section

Assumption	Value	Probability	Decision(5%)
Skewness	0.9091	0.363315	Accepted
Kurtosis	2.2330	0.025547	Rejected
Omnibus	5.8128	0.054671	Accepted

Serial-Correlation Section

Lag	Correlation	Lag	Correlation	Lag	Correlation
1	0.120003	9	0.091533	17	-0.057428
2	-0.280154	10	-0.128723	18	-0.064190
3	-0.310203	11	-0.120973	19	0.053514
4	0.170672	12	-0.062546	20	0.014712
5	0.208626	13	-0.134322	21	0.094524
6	-0.168922	14	0.146646	22	-0.048111
7	-0.088579	15	0.111027	23	0.032244
8	-0.089416	16	0.059356	24	-0.049290

Above serial correlations significant if their absolute values are greater than 0.408248
Durbin-Watson Value 1.3911

Table F-59. Projected Ornamental Nursery Acreage in Lee County.

Year	Primary - 15%	Primary	Primary + 15%
1995	1,108	1,303[a]	1,498
1996	1,320	1,553[a]	1,786
1997	1,352	1,591	1,829
2000	1,448	1,703	1,959
2005	1,610	1,895	2,179
2010	1,776	2,089	2,402
2015	1,943	2,286	2,628
2020	2,111	2,484	2,857

a. From **Table F-58**.

Supplemental water requirements(**Table F-60**) were applied to ornamental nursery acreage projections (**Table F-59**) to calculate the irrigation requirements for ornamental nurseries shown in **Table F-60**. Calculations were made using data collected from the Fort Myers rainfall station and soil with a water holding capacity of 0.8 in./ft.

Table F-60. Irrigation Requirements for the Primary Ornamental Nursery Acreage Projections in Lee County.

Year		1995	2000	2005	2010	2015	2020
Lee County Acreage[a]		1,303	1,703	1,895	2,089	2,286	2,484
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	1.00	71	92	103	113	124	135
February	1.29	91	119	133	146	160	174
March	2.87	203	265	295	326	356	387
April	4.04	286	374	416	458	502	545
May	4.41	312	408	454	500	548	595
June	2.57	182	238	265	292	319	347
July	3.24	229	300	333	368	402	437
August	3.04	215	281	313	345	377	410
September	2.22	157	205	228	252	276	300
October	3.09	219	286	318	351	384	417
November	2.51	178	232	258	285	312	339
December	1.76	125	163	181	200	219	237
Total	31.95	2,261	2,955	3,288	3,625	3,967	4,310
1-in-10							
January	1.26	89	117	130	143	156	170
February	1.37	97	127	141	155	170	185
March	3.55	251	328	365	403	441	479
April	4.71	333	436	485	534	585	635
May	5.00	354	462	515	567	621	675
June	3.56	252	329	366	404	442	480
July	4.13	292	382	425	469	513	557
August	3.62	256	335	373	411	449	488
September	2.38	168	220	245	270	295	321
October	3.60	255	333	371	408	447	486
November	2.61	185	241	269	296	324	352
December	1.88	133	174	193	213	233	254
Total	37.68	2,667	3,485	3,878	4,275	4,678	5,083

a. Acreages are from **Table F-59**.

Hendry Area Ornamental Nurseries

Only the portion of Hendry County within the LWC Planning Area has ornamental nurseries. Therefore, the historic and projected acreages are the same for both the whole county and the Hendry Area. Historic acreage is presented in **Table F-61.**

Table F-61. Historic Ornamental Nursery Acreage in Hendry County and the Hendry Area.

Year	Historic	Year	Historic
1972	1,005	1985	124
1973	111	1986	200
1974	37	1987	245
1975	263	1988	487
1976	49	1989	281
1977	59	1990	930
1978		1991	1,294
1979	67	1992	1,340
1980	77	1993	1,266
1981	126	1994	1,135
1982	150	1995	1,067
1983	110	1996	1,047
1984	164		

An equation of the form **Equation F-39** was used to project ornamental nursery acreage for the Hendry Area.

$$A_i = f(t, D_t) \qquad (F\text{-}39)$$

where:

A_i = *ornamental nursery acreage in the Hendry Area in year i.*

t = *a trend variable which takes on a value of one in 1972 and is increased by one unit per year*

D_t = *a dichotomous variable which takes on a value of one for the period 1976-1989 inclusive and zero otherwise. For projection purposes the value of* D_t *is held at zero throughout the period to be projected.*

Equation F-39 was estimated and **Equation F-40** resulted. In **Equation F-40** below, estimated using ordinary least squares, the variables were defined as:

Historic = *historic Hendry County ornamental nursery acreage*

D_1 = *a zero-one dichotomous variable equal to one for the period 1976-1989 and zero otherwise. For projection purposes* D_1 *was held at zero.*

t = *a time trend variable taking on the value of one in 1972 and increasing one unit per year thereafter.*

When the Hendry Area ornamental nursery acreage projected using **Equation F-40**, the results shown in **Table F-62** were obtained.

(F-40)

Multiple Regression Report

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Dependent Historic

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	330.6841	113.9374	2.9023	0.008520	Reject Ho	0.790316
D1	-589.2336	91.02675	-6.4732	0.000002	Reject Ho	0.999986
TIME	35.71216	6.253393	5.7108	0.000011	Reject Ho	0.999744
R-Squared	0.817781					

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	330.6841	113.9374	93.73824	567.63	0.0000
D1	-589.2336	91.02675	-778.5341	-399.9331	-0.6168
TIME	35.71216	6.253393	22.70752	48.7168	0.5442
T-Critical	2.079614				

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	5638467	5638467			
Model	2	4446914	2223457	47.1231	0.000000	0.999972
Error	21	990865.2	47184.05			
Total(Adjusted)	23	5437779	236425.2			

Root Mean Square Error	217.2189	R-Squared	0.8178
Mean of Dependent	484.7021	Adj R-Squared	0.8004
Coefficient of Variation	0.4481493	Press Value	1574254
Sum |Press Residuals|	4242.887	Press R-Squared	0.7105

Normality Tests Section

Assumption	Value	Probability	Decision(5%)
Skewness	2.1100	0.034862	Rejected
Kurtosis	2.2874	0.022172	Rejected
Omnibus	9.6842	0.007890	Rejected

Serial-Correlation Section

Lag	Correlation	Lag	Correlation	Lag	Correlation
1	0.113491	9	0.030588	17	-0.188701
2	-0.292463	10	0.077493	18	-0.275455
3	-0.274108	11	0.080209	19	-0.006402
4	-0.013650	12	0.092865	20	0.132678
5	0.002015	13	-0.055909	21	0.188035
6	-0.059219	14	-0.048341	22	0.095951
7	-0.051724	15	0.026307	23	-0.026038
8	-0.073768	16	0.140154	24	-0.114009

Above serial correlations significant if their absolute values are greater than 0.408248
Durbin-Watson Value 1.3212

Table F-62. Projected Ornamental Nursery Acreage in Hendry County and the Hendry Area.

Year	Primary - 15%	Primary	Primary + 15%
1995	907	1,067[a]	1,227
1996	890	1,047[a]	1,204
2000	1,011	1,190	1,368
2005	1,163	1,368	1,573
2010	1,315	1,547	1,779
2015	1,466	1,725	1,984
2020	1,618	1,904	2,189

a. From **Table F-61**.

Supplemental water requirements for sod on soil with a water holding capacity of 0.8 in./ft.soil in the Hendry Area (**Table F-63**) were applied to the ornamental nursery acreage projections (**Table F-62**) to calculate the irrigation requirements shown in **Table F-63**. Rainfall data used was from the LaBelle station.

Table F-63. Irrigation Requirements for the Primary Ornamental Nursery Acreage Projections in the Hendry Area.

Year		1995	2000	2005	2010	2015	2020
Hendry County Acreage[a]		1,067	1,190	1,368	1,547	1,725	1,904
Hendry Area Acreage		1,067	1,190	1,368	1,547	1,725	1,904
Month	**Supplemental Water Requirements (inches/acre)**	**Irrigation Requirements (millions of gallons)**					
1-in-2							
January	0.93	36	40	46	52	58	64
February	1.15	44	50	57	64	72	79
March	2.62	101	113	130	147	164	181
April	3.68	142	159	182	206	230	254
May	4.12	159	178	204	231	257	284
June	2.54	98	109	126	142	159	175
July	3.39	131	146	168	190	212	234
August	3.30	127	142	163	185	206	228
September	2.84	110	122	141	159	177	196
October	2.84	110	122	141	159	177	196
November	2.32	90	100	115	130	145	160
December	1.58	61	68	78	89	99	109
Total	31.32	1,210	1,350	1,551	1,754	1,956	2,159
1-in-10							
January	1.16	45	50	57	65	72	80
February	1.30	50	56	64	73	81	90
March	3.41	132	147	169	191	213	235
April	4.38	169	189	217	245	274	302
May	4.65	180	200	230	260	290	321
June	3.44	133	148	170	193	215	237
July	3.94	152	170	195	221	246	272
August	3.55	137	153	176	199	222	245
September	3.40	131	146	168	190	212	234
October	3.26	126	140	161	183	204	225
November	2.26	87	97	112	127	141	156
December	1.50	58	65	74	84	94	103
Total	36.25	1,400	1,562	1,796	2,030	2,264	2,499

a. Acreages are from **Table F-62**.

Glades Area Ornamental Nurseries

All of the Glades County ornamental nursery acreage is located within the LWC portion of the county. Therefore, the historic and projected acreages are the same for both the whole county and the Glades Area. Historic acreage is presented in **Table F-64**.

Table F-64. Historic Ornamental Nursery Acreage in Glades County and the Glades Area.

Year	Historic	Year	Historic
1979	4	1988	607
1980	68	1989	409
1981	83	1990	502
1982	83	1991	1,392
1983	68	1992	1,429
1984	103	1993	1,476
1985	109	1994	1,472
1986	164	1995	1,431
1987	528	1996	1,310

In order to forecast ornamental nursery acreage for the Glades Area, a model was developed using data for the period 1976 through 1996. The functional form of this model is outlined in **Equation F-41**.

$$Glncn_i = f(t, D_i) \qquad (F\text{-}41)$$

where:

$Glncn_i$ = *acreage of Glades ornamental nursery in year i.*

t = *a trend variable which takes on a value of four in 1979 and increases by one unit each year.*

D_i = *a dichotomous variable where D_i is one in 1992 through 1995 inclusive and zero otherwise.*

The model which was estimated using ordinary least squares is shown in **Equation F-42**, which was adjusted to generate the primary projection for Glades Area ornamental nursery acreage. In equation F-37 below, estimated using ordinary least squares , the variables were defined as:

GLNONCIT= Glades County non-citrus nursery acreage

Time = a time trend variable equal to four in 1979 and increase one unit per year thereafter. Data for the years 1976 through 1978 inclusive were excluded from the analysis because of the insignificant acreage of nurseries in Glades County

D = a zero-one dichotomous variable equal to one in 1992 through 1995 inclusive and zero otherwise. This period corresponds to the period of peak ornamental nursery acreage in Glades County.

The resulting projections are shown in **Table F-65.**

Table F-65. Projected Ornamental Nursery Acreage in Glades County and the Glades Area.

Year	Primary - 15%	Primary	Primary + 15%
1995	1,216	1,431	1,646
1996	1,114	1,310	1,507
2000	1,392	1,637	1,883
2005	1,740	2,047	2,354
2010	2,087	2,456	2,824
2015	2,435	2,865	3,295
2020	2,783	3,274	3,765

(F-42)

Multiple Regression Report

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Filter	Year>1978
Dependent	GLNONCIT

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	-494.8523	144.7866	-3.4178	0.003816	Reject Ho	0.891066
Time	81.84061	12.33783	6.6333	0.000008	Reject Ho	0.999987
D	432.801	153.9671	2.8110	0.013164	Reject Ho	0.747828
R-Squared	0.889959					

Regression Coefficient Section

Independent Variable	Regression Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	Standardized Coefficient
Intercept	-494.8523	144.7866	-803.4577	-186.2469	0.0000
Time	81.84061	12.33783	55.54314	108.1381	0.7228
D	432.801	153.9671	104.6278	760.9742	0.3063
T-Critical	2.131450				

Analysis of Variance Section

Source	DF	Sum of Squares	Mean Square	F-Ratio	Prob Level	Power (5%)
Intercept	1	7016258	7016258			
Model	2	5528082	2764041	60.6565	0.000000	0.999998
Error	15	683531.8	45568.79			
Total(Adjusted)	17	6211614	365389.1			

Root Mean Square Error	213.4685	R-Squared	0.8900
Mean of Dependent	624.3333	Adj R-Squared	0.8753
Coefficient of Variation	0.3419143	Press Value	957541.6
Sum |Press Residuals|	3163.631	Press R-Squared	0.8458

Normality Tests Section

Assumption	Value	Probability	Decision(5%)
Skewness	2.1806	0.029213	Rejected
Kurtosis	2.0843	0.037134	Rejected
Omnibus	9.0993	0.010571	Rejected

Serial-Correlation Section

Lag	Correlation	Lag	Correlation	Lag	Correlation
1	0.135196	9	-0.034080	17	0.021626
2	-0.167913	10	-0.028307	18	
3	-0.010295	11	0.089969	19	
4	-0.023783	12	0.177211	20	
5	-0.062573	13	0.024334	21	
6	-0.215276	14	-0.006046	22	
7	-0.228474	15	-0.026617	23	
8	-0.128282	16	-0.016691	24	

Above serial correlations significant if their absolute values are greater than 0.471405

Durbin-Watson Value 1.6757

Supplemental water requirements for sod on a soil with a 0.8 in./ft. water holding capacity in the Glades Area (**Table F-66**) were applied to the ornamental nursery acreage projections (**Table F-65**) to calculate the irrigation requirements shown in **Table F-66**. Rainfall data was from the Moore Haven station.

Table F-66. Irrigation Requirements for the Primary Ornamental Nursery Acreage Projections in the Glades Area.

Year		1995	2000	2005	2010	2015	2020
Glade County and Glades Area Acreage[a]		1,431	1,637	2,047	2,456	2,865	3,274
Month	Supplemental Water Requirements (inches/acre)	Irrigation Requirements (millions of gallons)					
1-in-2							
January	0.96	75	85	107	128	149	171
February	1.14	89	101	127	152	177	203
March	2.61	203	232	290	348	406	464
April	3.68	286	327	409	491	573	654
May	4.12	320	366	458	550	641	733
June	3.27	254	291	364	436	509	581
July	3.86	300	343	429	515	601	686
August	3.78	294	336	420	504	588	672
September	2.75	214	244	306	367	428	489
October	3.05	237	271	339	407	475	542
November	2.34	182	208	260	312	364	416
December	1.65	128	147	183	220	257	293
Total	33.19	2,580	2,951	3,690	4,427	5,164	5,902
1-in-10							
January	1.13	88	100	126	151	176	201
February	1.26	98	112	140	168	196	224
March	3.34	260	297	371	446	520	594
April	4.32	336	384	480	576	672	768
May	4.81	374	428	535	642	748	855
June	4.22	328	375	469	563	657	750
July	4.57	355	406	508	610	711	813
August	4.07	316	362	452	543	633	724
September	3.18	247	283	354	424	495	565
October	3.54	275	315	394	472	551	629
November	2.40	187	213	267	320	373	427
December	1.78	138	158	198	237	277	317
Total	38.62	3,002	3,434	4,294	5,152	6,009	6,867

a. Acreages are from **Table F-65**.

Improved Pasture/Cattle Watering

Improved pasture has, by District definition, the facilities in place to carry out irrigation. However, these facilities were usually designed and installed for drainage and are rarely used for irrigation. This is because the returns associated with cattle production no longer justify the expense associated with pasture irrigation. When irrigation is carried out it is usually in a period of extreme drought and is done to prevent grass from dying. The assumption is made here that improved pasture will not be irrigated throughout the projection period. Although this assumption may not be the case in some rare instances, it is much closer to actual production practices than the values given by any irrigation requirement model.

Total pasture acreage, improved and unimproved, does affect the water required for stock watering by limiting cattle population. Total pasture was projected by subtracting land expansion for other purposes from the current acreage of pasture. Note that pasture acreage includes wetlands which will not be converted to other agricultural uses.

Water required for stock watering was calculated as a function of the number and type of cattle (beef or dairy), which, in turn, was appraised as a function of the acreage used for pasture. Water demand projections for stock watering are based on the District allocation of 12 gallons/day/cow for beef cattle and 150 gallons/cow/day for dairy cattle.

Collier County Cattle Watering

The 1990 Collier County pasture acreage estimate was obtained from the local IFAS extension office. Historical and primary projected changes in acreage for other uses were applied to that figure. The resulting projections for pasture acreage are presented in **Table F-67.** In 1995, Collier County had approximately 14,500 head of cattle (FASS, 1977) with no significant amount for dairy use. These cattle account for 330,000 acres of improved and unimproved pasture.

Table F-67. Projected Water Use for Cattle Watering in Collier County.

Year	Approximate Head of Cattle	Million Gallons/ Day	Million Gallons/ Year
1995	14,500	0.18	64
2000	14,000	0.17	61
2005	13,000	0.16	57
2010	12,500	0.15	55
2015	11,500	0.14	50
2020	10,500	0.13	46

Lee County Cattle Watering

The 1990 pasture acreage estimate was obtained from the local IFAS extension office. Historical and primary projected changes in acreage for other uses were applied to that figure. In 1995 Lee County had 15,000 head of beef cattle and no dairy cattle (FASS, 1997). The association between cattle and acreage is approximately 7.9 acres per head of cattle.

The acreage of pasture and the corresponding population of beef cattle will be reduced with the expansion of other crops in Lee County. This projected reduction in beef cattle population and the related water use for cattle watering (based on the primary acreage projections of other crops) is shown in **Table F-68**.

Table F-68. Projected Water Use for Cattle Watering in Lee County.

Year	Approximate Head of Cattle	Million Gallons/ Day	Million Gallons/ Year
1995	15,000	0.18	66
2000	14,700	0.18	64
2005	14,400	0.17	63
2010	14,000	0.17	61
2015	13,600	0.16	60
2020	13,300	0.16	58

Hendry Area Cattle Watering

In 1995, Hendry County had 109,000 head of beef cattle (FASS). It is estimated that 42 percent of the cattle are in the Hendry Area. The acreage of pasture and the corresponding population of cattle will be reduced with the expansion of other crops in the Hendry Area. This projected reduction in cattle population and the related water use for cattle watering is shown in **Table F-69**.

Table F-69. Projected Water Use for Cattle Watering in Hendry County and the Hendry Area.

Year	Approximate Head of Cattle		Million Gallons/Day	Million Gallons/Year
	Hendry County	Hendry Area		
1995	109,000	45,780	0.55	201
2000	117,000	49,140	0.59	215
2005	112,000	47,040	0.56	206
2010	107,000	44,940	0.54	197
2015	102,000	42,840	0.51	188
2020	97,500	40,950	0.49	179

Glades Area Cattle Watering

The 1995, Glades County had 76,000 head of beef cattle. Of these 76,000, approximately one-third, or 25,333, were in the Glades Area. The association between cattle and acreage is about 5.1 acres per head of cattle. This projected reduction in beef cattle population and the related water use for cattle watering is shown in **Table F-70**.

In 1989/1990, Glades County had approximately 4,000 head of dairy cattle. The dairy cattle population in Glades County is expected to remain relatively constant over the projection period.

Table F-70. Historic and Projected Cattle Water Use in Glades County and the Glades Area.

Year	Approximate Head of Cattle		Million Gallons/Day	Million Gallons/Year
	Glades County	Glades Area		
1995	76,000	25,333	0.304	111
2000	74,000	24,667	0.296	108
2005	71,000	23,667	0.284	104
2010	69,000	23,000	0.276	101
2015	66,000	22,000	0.264	96
2020	64,000	21,333	0.256	93

Charlotte Area Cattle Watering

There is little cattle raising in the Charlotte Area. Within the limits of estimation error, cattle watering use in the Charlotte Area is estimated at zero.

Aquaculture

Collier County Aquaculture

All aquacultural operations within the LWC Planning Area are located within Collier County. Aquacultural operations withdraw water for circulation purposes and to replace evaporative losses. The replacement amount, based on District permit allocations, was assessed at 376 MGY in 1995 and is projected to remain at this level through 2020.

TOTAL IRRIGATED ACREAGE

Irrigated acreages for the LWC Planning Area are presented in **Table F-71**.

Table F-71. Irrigated Acreages for the Lower West Coast Planning Area.

Use Classification	1995 Acreage	2020 Acreage
COLLIER COUNTY		
URBAN		
Golf Course Self-Supplied	5,225	10,703
Golf Course Reuse-Supplied	3,807	8,585
Landscape	7,527	14,368
TOTAL COLLIER COUNTY URBAN	16,559	33,656
AGRICULTURE		
Citrus	36,559	55,966
Vegetables	24,126	13,587
Ornamental Nursery	1,288	1,965
TOTAL COLLIER COUNTY AGRICULTURE	61,973	71,518
LEE COUNTY		
URBAN		
Golf Course Self-Supplied	4,398	9,402
Golf Course Reuse-Supplied	2,956	4,625
Landscape	6,076	9,623
TOTAL LEE COUNTY URBAN	13,430	23,650
AGRICULTURE		
Citrus	12,197	16,150
Tropical Fruit	1,930	3,180
Vegetables	10,062	796
Sod	650	650
Ornamental Nursery	1,303	2,484
TOTAL LEE COUNTY AGRICULTURE	26,142	23,260
HENDRY AREA		
URBAN		
Golf Course Self-Supplied	233	233
Golf Course Reuse-Supplied	19	19
TOTAL HENDRY AREA URBAN	252	252
AGRICULTURE		
Citrus[a]	71,415	81,909
Citrus Nursery	145	145
Sugarcane[b]	35,443	36,927
Vegetables	7,264	5,265
Cut Flowers	1,000	1,000
Ornamental Nursery	1,067	1,904
TOTAL HENDRY AREA AGRICULTURE	116,334	127,150
GLADES AREA		
URBAN		

Table F-71. (Continued) Irrigated Acreages for the Lower West Coast Planning Area.

Use Classification	1995 Acreage	2020 Acreage
Golf Course Self-Supplied	15	15
Golf Course Reuse-Supplied	5	5
Total Glades Area Urban	20	20
AGRICULTURE		
Citrus	4,855	8,261
Sugarcane	16,295	16,295
Rice	200	800
Vegetables	473	473
Ornamental Nursery	1,431	3,274
TOTAL GLADES AREA AGRICULTURE	23,254	29,103
CHARLOTTE AREA		
AGRICULTURE		
Citrus	3,088	4,308
Seed Corn and Soybeans	3,100	3,100
Vegetables	2,306	2,306
TOTAL CHARLOTTE AREA AGRICULTURE	8,494	9,714
LWC PLANNING AREA (Totals)		
URBAN		
Golf Course Self-Supplied	10,004	20,486
Golf Course Reuse-Supplied	6,788	13,235
Landscape	13,603	13,603
AGRICULTURE		
Citrus[a]	128,114	166,594
Citrus Nursery	145	145
Sugarcane[b]	51,738	53,222
Seed Corn and Soybeans	3,100	3,100
Rice	200	800
Tropical Fruit	1,930	3,180
Vegetables	44,231	22,427
Sod	650	650
Cut Flowers	1,000	1,000
Ornamental Nursery	5,089	9,627
LWC PLANNING AREA TOTAL AGRICULTURE	236,197	260,745
LWC PLANNING AREA TOTAL URBAN	30,395	47,324
LWC PLANNING AREA GRAND TOTAL	266,592	308,069

a. An additional 12,748 gross acres of citrus were added for modeling purposes resulting in a total of 125,035 gross acres in the Caloosahatchee basin. To prevent misrepresentation, gross acreages and net acreages are not combined in this table.

b. An additional 45,210 gross acres of sugarcane were added for modeling purposes resulting in a total of 125,007 gross acres in the Caloosahatchee basin. To prevent misrepresentation, gross acreages and net acreages are not combined in this table.

TOTAL AVERAGE ANNUAL WATER DEMAND

Estimated and projected demands for the LWC Planning Area are shown in **Table F-72**. Demands are presented by land use classification, with agricultural use broken down into its components. Neither the Charlotte or Monroe county areas have significant urban demands. The Monroe County Area has no significant agricultural demands. Total estimated and projected demands for the LWC Planning Area are shown in **Table F-73**.

Table F-72. Annual Water Demand by Use Classification.

Use Classification	Annual Water Demand (MGY)	
	1995	2020
COLLIER COUNTY		
URBAN		
Public Water Supplied	16,213	29,930
Domestic Self-Supplied	1,971	2,172
Commercial and Industrial Self-Supplied	2,181	4,163
Recreation		
Landscape Self-Supplied	10,093	19,267
Golf Course Self-Supplied	6,548	14,161
Golf Course Reuse	4,772	11,358
Golf Course Total	11,320	25,519
Recreation Total	21,413	44,786
Recreation Self-Supply (to compare with Table F-7)	16,641	33,428
TOTAL URBAN	**41,778**	**81,051**
AGRICULTURE		
Citrus	29,714	45,487
Vegetables	14,518	8,176
Ornamental Nursery	2,360	3,600
Cattle Watering	64	46
Aquaculture	376	376
TOTAL AGRICULTURE	**47,032**	**57,685**
TOTAL COLLIER COUNTY WATER DEMAND	**88,810**	**138,736**
LEE COUNTY		
URBAN		
Public Water Supplied	15,662	24,320
Domestic Self-Supplied	2,197	3,154
Commercial and Industrial Self-Supplied	1,974	3,126
Recreation		
Landscape Self-Supplied	7,012	11,105
Golf Course Self-Supplied	4,999	10,686
Golf Course Reuse	3,359	5,257
Golf Course Total	8,358	15,943
Recreation Total	15,370	27,048
Recreation Self-Supply (to compare with Table F-7)	12,011	21,791
Thermoelectric Power Generation Self-Supply	281	281

Table F-72. (Continued) Annual Water Demand by Use Classification.

Use Classification	Annual Water Demand (MGY)	
	1995	2020
TOTAL URBAN	**35,484**	**57,929**
AGRICULTURE		
Citrus	9,652	12,780
Tropical Fruit	2,103	3,465
Vegetables	6,459	511
Sod	1,128	1,128
Ornamental Nursery	2,261	4,310
Cattle Watering	66	58
TOTAL AGRICULTURE	**21,669**	**22,252**
TOTAL LEE COUNTY WATER DEMAND	**57,153**	**80,181**
HENDRY AREA		
URBAN		
Public Water Supplied	1,456	2,183
Domestic Self-Supplied	632	829
Recreation		
Landscape Self-Supplied	0	0
Golf Course Self-Supplied	267	267
Golf Course Reuse	14	14
Golf Course Total	281	281
Recreation Total	281	281
Recreation Self-Supply (to compare with Table F-7)	267	267
TOTAL URBAN	**2,355**	**3,293**
AGRICULTURE		
Citrus	66,782	76,595
Citrus Nursery	160	160
Sugarcane	46,616	47,348
Vegetables	12,328	7,770
Cut Flowers	1,199	1,199
Ornamental Nursery	1,210	2,159
Cattle Watering	201	179
TOTAL AGRICULTURE	**128,496**	**135,410**
TOTAL HENDRY AREA WATER DEMAND	**130,789**	**138,703**
GLADES AREA		
URBAN		
Public Water Supplied	106	183
Domestic Self-Supplied	113	190
Recreation		
Landscape Self-Supplied	0	0
Golf Course Self-Supplied	24	24
Golf Course Reuse	9	9
Golf Course Total	33	33
Total Recreation	33	33

Table F-72. (Continued) Annual Water Demand by Use Classification.

Use Classification	Annual Water Demand (MGY)	
	1995	2020
Recreation Self-Supply (to compare with Table F-7)	24	24
TOTAL URBAN	**252**	**406**
AGRICULTURE		
Citrus	4,020	6,841
Sugarcane	23,134	23,134
Rice	175	699
Vegetables	286	286
Ornamental Nursery	2,580	5,902
Cattle Watering	111	93
TOTAL AGRICULTURE	**30,306**	**36,955**
TOTAL GLADES AREA WATER DEMAND	**30,558**	**37,361**
CHARLOTTE AREA		
URBAN		
Public Water Supplied	0	0
Domestic Self-Supplied	29	84
TOTAL URBAN	**29**	**84**
AGRICULTURE		
Citrus	2,396	3,343
Seed Corn and Soybeans	1,782	1,782
Vegetables	1,360	1,360
TOTAL AGRICULTURE	**5,538**	**6,485**
TOTAL CHARLOTTE AREA WATER DEMAND	**5,567**	**6,569**

Table F-73. Total Annual Water Demand by Use Classification.

LWC PLANNING AREA TOTAL BY USE (MGY)	Estimated 1995	Estimated 2020	Percent of Use 1995	Percent of Use 2020
URBAN				
Public Water Supplied	33,438	56,615	10.7	14.1
Domestic Self-Supplied	4,942	6428	1.6	1.6
Commercial and Industrial Self-Supplied	4,155	7,289	1.3	1.8
Recreation	37,097	72,148	11.9	18.0
Thermoelectric Power Generation Self-Supply	281	281	0.1	0.1
TOTAL URBAN	**79,913**	**142,761**	**25.5**	**35.6**
AGRICULTURE				
Citrus	112,564	145,046	36.0	36.1
Citrus Nursery	160	160	0.1	0.0
Sugarcane	69,750	70,482	22.3	17.6
Rice	175	699	0.1	0.2
Seed Corn and Soybean	1,782	1,782	0.6	0.4
Tropical Fruit	2,103	3,465	0.7	0.9
Vegetables	34,951	18,103	11.2	4.5
Sod	1,128	1,128	0.4	0.3
Cut Flowers	1,199	1,199	0.4	0.3
Ornamental Nursery	8,411	15,971	2.7	4.0
Cattle Watering	442	376	0.1	0.1
Aquaculture	376	376	0.1	0.1
TOTAL AGRICULTURE	**233,041**	**258,787**	**74.5**	**64.4**
TOTAL ANNUAL WATER DEMAND FOR THE LWC PLANNING AREA	**312,954**	**401,548**	**---**	**---**

REFERENCES CITED

Behr R., M. Brown, and G. Fairchild. 1988. *Florida Citrus Production Trends 1989-1990 through 1998-1999*. Florida Department of Citrus, University of Florida, Gainesville, FL. 21 pp.

Cornish G., and R. Whitten. 1988. *The Golf Course*. New York: The Rutledge Press.

Florida Cattlemen's Association. 1990. Okeechobee still has the most cows; Osceola ranks second in beef cows. *The Florida Cattleman and Livestock Journal*, 54 (9): 60.

Florida Department of Agriculture and Consumer Services. 1972-1990. *Annual Report*. Division of Plant Industry, FDACS, Gainesville, FL. Multi-volumes.

Florida Department of Agriculture and Consumer Services. 1989-1990. *Citrus Summary.* Florida Agricultural Statistics Service, FDACS, Orlando, FL. 45 pp.

Florida Department of Agriculture and Consumer Services. 1966-1990. *Commercial Citrus Inventory.* Florida Agricultural Statistics Service, FDACS, Orlando, FL. Multi-volumes.

Florida Department of Agriculture and Consumer Services. 1975-1990. *Field Crops Summary.* Florida Agricultural Statistics Service, FDACS, Orlando, FL Multi-volumes.

Florida Department of Agriculture and Consumer Services. 1974-1990. *Vegetable Summary.* Florida Agricultural Statistics Service, FDACS, Orlando, FL. Multi-volumes.

Florida Department of Commerce. 1990. *The Official Florida Golf Guide*. Office of Sports Promotion, FDOC, Tallahassee, FL.

Florida Golfweek. 1989. Golf Guide to the South. *Florida Golfweek*, Dundee, FL.

Intriligator, Michael D. 1978. *Econometric Models, Techniques, and Applications*. Englewood Cliffs: Prentice-Hall, Inc.

Mahmoud E. 1984. Accuracy in forecasting: a survey. *Journal of Forecasting*, 3 (2).

National Golf Foundation. 1997. *Golf Course Directory.* National Golf Foundation, Jupiter, FL.

Smajstrla A.G., B. Boman, G. Clark, D. Haman, D. Harrison, F. Izuno, D. Pitts, and F. Zazueta. 1991. *Efficiencies of Florida Agricultural Irrigation Systems*. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL. 11 pp.

South Florida Water Management District. 1987. *Water Resources Data and Related Technical Information to Assist Local Government Planning in Charlotte County.* SFWMD, West Palm Beach, FL.

South Florida Water Management District. 1998, *Districtwide Water-Supply Assessment*, Planning Department, SFWMD, West Palm Beach, FL. Vari pag.

Strategic Mapping, Inc. 1992. Block Groups, Census Tract and Data #2A & #2B for the State of Florida on CD-ROM.

U.S. Bureau of the Census. 1992. Census of Population and Housing, 1990: Summary Tape 3 on CD-ROM - Florida. Washington, D.C.

U.S. Geological Survey. 1989. *Water Resources Data Florida, Water Year 1989-- Volume 3B*, Southwest Florida Ground Water. U.S. Geological Survey Water-Data Report FL-89-3B. U.S. Geological Survey, Tampa, FL. 327 pp.